

***Massachusetts Avenue District***  
***Bulk Substation Transformer Outages***  
***Distribution Supply Line Outages***  
***Thermal Results and Remedial Switching Actions***

## ***2004 T&D OPERATING STUDY MASS. AVENUE DISTRICT***

### **STATION #2 HAWKINS STREET**

Hawkins Street Station #2 supplies all or parts of the Beacon Hill, Charles Circle, West End and Government Center regions of the City of Boston. In the summer of 2002 the Hawkins Street Station #2 load was 82 MVA.

Hawkins Street Station #2 consists of the following transformers:

Transformer #110A: General Electric 75 / 84 MVA 110 kV to 13.8 / 13.8 kV

Transformer #110B: General Electric 75 / 84 MVA 110 kV to 13.8 / 13.8 kV

Hawkins Street Station #2 total capacity is 168 MVA. NSTAR employs summer emergency rating (cyclic capability) of 93 MVA for each of these transformer banks. The station has a firm capacity of 93 MVA. As a secondary network station there is no transfer switching capability to adjacent network stations. Hawkins Street's load carrying capability (i.e. firm capacity + transfer switching) is 93 MVA.

### **Overload Ratings:**

Transformer	Nameplate	12 hour LTE, 90F Ambient	12 hour LTE, 110F Ambient
110A	75 / 84 MVA	107 MVA	100 MVA
110B	75 / 84 MVA	107 MVA	100 MVA

### **Station Capabilities:**

Total Station Capacity (N)	Station Firm Capacity (LTE)	RADSEC Transfer	Manual Transfer	Total LCC
150 MVA	93 MVA*	0 MVA	0 MVA	93 MVA

Based upon loss of either 110A/250-517 line or 110B/250-516 line.

### **2004-2008 Projected load:**

2004	2005	2006	2007	2008
92 MVA	93 MVA	94 MVA	96 MVA	95 MVA

### **Switching Actions:**

Loss of Transformer #110A and the 250-517 Line:

**Open:** OCB's 2 & 3 @ Mystic  
Circuit Switcher CS771

110A-1 and 110A-3 13.8kV Secondary Circuit Breakers

**Close:** The ABR scheme closes the normally open section #1 to tie bus breaker.  
OCB's 2 & 3 @ Mystic are manually closed.

Loss of Transformer #110B and the 250-516 Line:

**Open:** OCB's 9 & 10 @ Mystic  
Circuit Switcher CS770

110B-2 and 110B-4 13.8kV Secondary Circuit Breakers

**Close:** The ABR scheme closes the normally open section #1 to tie bus breaker.  
OCB's 9 & 10 @ Mystic are manually closed

The description above assumes circuit switchers CS-772 and CS-776 are open at Chatham St.

**Summary of Concerns:**

1. Hawkins Street Station #2 is overloaded under contingency conditions (2006)
2. Network feeders overloaded under contingency conditions (2004-2005)

Without any significant major development projects during 2004-2008, the Hawkins Street Supply region is projected to experience meager load growth; approximately 0.8% annual load growth. Based on load projections, by the summer of 2006 for a single-contingency outage of either transformer 110A or 110B, Hawkins Street Station #2 will exceed the firm capacity. The new load will strain the capability of Hawkins Street #2's substation and distribution infrastructure to support the customer load requirements. Since Hawkins Street Station #2 is a secondary network station the load at risk is the entire station 94 MW.

**Distribution Systems**

**DSS Lines**

Hawkins Station #2 supplies the Mass General line group.

The **Mass General Line Group** consists of DSS lines 575-211, 575-212, 575-213 and 575-214. The line group supplies Mass General Customer Station #575. Upon the loss of either DSS line, the remaining DSS line will not exceed the long-term emergency capacity (LTE), based on 2004-2008 peak load projections.

DSS Line	% of Normal 2004	LTE - % Load at Risk 2004	MVA at Risk 2004	LTE - % Load at Risk 2008	MVA at Risk 2008
575-211	54%	0%	0	0%	0
575-212	60%	0%	0	0%	0
575-213	68%	0%	0	0%	0
575-214	56%	0%	0	0%	0

**14 kV Network Feeders**

There are sixteen network feeders supplied from Hawkins Station #2. By the summer 2004 network feeder 2-1N33 will exceed the 100% normal rating and two other feeders will be heavily loaded exceeding 90% of normal rating. The following table summarized the performance of the network feeders.

<b>14kV Network Lines</b>	<b>% of Normal 2002</b>	<b>Projected % of Normal 2004</b>	<b>Projected% of Normal 2008</b>
2-1N11	64%	71%	74%
2-1N12	16%	68%	66%
2-1N14	86%	97%	100%
2-1N15	57%	61%	67%
2-1N21	50%	56%	58%
2-1N23	22%	24%	25%
2-1N25	56%	63%	65%
2-1N26	85%	95%	98%
2-1N30	63%	70%	72%
2-1N33	34%	106%	109%
2-1N34	39%	44%	45%
2-1N35	53%	59%	61%
2-1N41	64%	72%	74%
2-1N43	69%	77%	80%
2-1N44	57%	63%	66%
2-1N45	46%	51%	53%

***Loading on Hawkins Street Network Feeders.***

### **Proposed Integrated Plan**

Chatham Street Station #12 has approximately 10 MVA of spare transformer capacity and several spare feeder positions to support load growth. The plan would be to cut-over (i.e. transfer) small segments of the Secondary Network Vaults and/or Tertiary Network Vaults within the Beacon Hill/Government Center supplied by Hawkins Street Station #2 to Chatham Street Station #12. This solution would transfer up to 5-10 MVA of load from Hawkins Street Station #12 to Chatham Street Station #12 and reduce the loading of Hawkins Street Station #2 below its firm capacity of 93 MVA.

The heavy loading conditions on the network feeders will be addressed by extending and reconductoring feeders within the network.

<b>Action</b>	<b>Year needed</b>	<b>Cost</b>
⇒ Reconductor and extend 2-1N12 to relieve 2-1N14	2004	\$200K
⇒ Reconductor and extend 2-1N34 to relieve 2-1N33	2004	\$150K
⇒ Reconductor and extend 2-1N23 to relieve 2-1N26	2005	TBD
⇒ Reconductor 2-1N30 to relieve 2-1N30	2005	TBD
⇒ Relieve Hawkins Street Station #12 by load transfer to Chatham Street Station #12.	2006	TBD



A  
C  
H  
R

UNIT

2-IN45	3 3 3 3	41-1841	6	1 3 3 3	STASER TRANS #2 (SEE STA SERV. DND)
2-IN44	3 3 3 3	41-1841	15	1 3 3 3	2-IN21
2-IN43	3 3 3 3	41-1841	14	1 3 3 3	575-212
575-214	3 3 3 3	41-1841	13	1 3 3 3	2-IN23
2-IN41	3 3 3 3	41-1841	12	1 3 3 3	TRANSF 110B
TRANSF 110B	3 3 3 3	41-1841	11	1 3 3 3	2-IN25
SEC4 TO TIE BUS	3 3 3 3	41-1841	10	1 3 3 3	2-IN26
SEC3 TO TIE BUS	3 3 3 3	41-1841	9	1 3 3 3	SEC2 TO TIE BUS
STASER TRANS #1 (SEE STA SERV. DND)	3 3 3 3	41-1841	8	1 3 3 3	2-IN11
2-IN35	3 3 3 3	41-1841	7	1 3 3 3	2-IN12
2-IN34	3 3 3 3	41-1841	6	1 3 3 3	575-211
2-IN33	3 3 3 3	41-1841	5	1 3 3 3	2-IN14
575-213	3 3 3 3	41-1841	4	1 3 3 3	2-IN15
2-IN30	3 3 3 3	41-1841	3	1 3 3 3	TRANSF 110A
TRANSF 110A	3 3 3 3	41-1841	2	1 3 3 3	UNIT

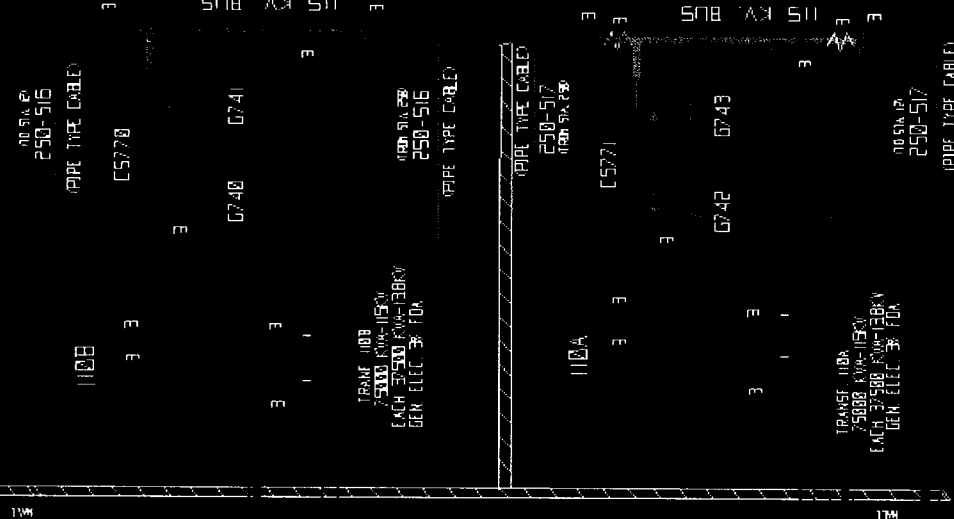
NOTES:

RETROFITTED VACUUM BREAKERS  
 AN-750-HL 3-GENERAL ELECTRIC TYPE AIR CIRCUIT BREAKERS  
 THERE ARE VIDEO CABLES BETWEEN STA'S 2 AND 21 WHICH  
 ARE TO BE CONNECTED AT STA 21 TO THE MICROWAVE SYSTEM  
 BETWEEN STA'S 21, 250, 369 AND 385  
 1-25 VOL. CONTROL BATTERY WITH CHARGE  
 0-24 VOLT ANNUNCIATOR BATTERY WITH CHARGE  
 0-24 VOLT ANNUNCIATOR BATTERY WITH CHARGE  
 GROUND LINE OF TRANSFORMER OF BOTH  
 PAID CONTROLLED VOLTAGE REDUCTION ONLY AVAILABLE  
 AT THIS STATION



ANSTAR ELECTRIC  
 AN INSTAR COMPANY

STATION 2  
 29 HAWKINS ST  
 BOSTON  
 TEL # (617) 523-8536  
 424-2075 (PAGE 1)



DATE MARCH 15, 1986

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## ***2004 T&D OPERATING STUDY MASS. AVENUE DISTRICT***

### **STATION #4 "L" STREET**

The L Street Station #4 and the new K Street Station #385D serve the South Boston section of Boston. L Street Station 4 (115/14 kV) serves a power supply area consisting of South Boston and the non-network load within portions of the South Station and Back Bay sections of the City of Boston. During the Summer 2002, the L Street Station 4 peak load was 113 MVA. L Street Station #4 consists of four 115/13.8 kV transformers. The station has a firm capacity of 140 MVA. There is no transfer switching to adjacent substations. L Street's load carrying capability (i.e. firm capacity + transfer switching) is 140 MVA. Upon completion of the K Street project, most of the L Street Station #4 load will be transferred to the new K Street Station #385D. The L Street Station #4 transformer 110C and 110D will be retired and L Street's firm capacity will be reduced to 84 MVA and projected peak load in 2004 will be reduced to 9 MVA (**See discussion for K Street #385D**).

Upon the completion of Phase 2 of the new K Street Station #385D, L Street Station #4 consists of the following transformers:

Transformer #110A: Westinghouse 75 / 84 MVA 110 kV to 13.8 / 13.8 kV

Transformer #110B: Westinghouse 75 / 84 MVA 110 kV to 13.8 / 13.8 kV

### **Overload Ratings:**

Transformer	Nameplate	12 hour LTE, 90F Ambient	12 hour LTE, 110F Ambient
110A	75 / 84 MVA	102 MVA	96 MVA
110B	75 / 84 MVA	102 MVA	96 MVA

### **Station Capabilities:**

Total Station Capacity (N)	Station Firm Capacity (LTE)	RADSEC Transfer	Manual Transfer	Total LCC
168 MVA	84 MVA*	0 MVA	0 MVA	84 MVA

### **2004-2008 Projected load:**

2004	2005	2006	2007	2008
9 MVA	9 MVA	10 MVA	10 MVA	10 MVA

### **Switching Actions:**

Loss of Transformer #110A:

**Open:** Circuit Breakers #5 and #6 at Station 385 K Street  
Disconnect Switch #T730 at Station 385 K Street

Both 110A Main 13.8kV Circuit Breakers at Station 4 L Street

**Close:** Bus Tie Breakers operate normally open, manually close switches.  
Circuit Breakers #5 and #6 at Station 385 K Street to close ring bus

Loss of Transformer #110B:

**Open:** Circuit Breakers #7 and #8 at Station 385 K Street

Disconnect Switch #T731 at Station 385 K Street

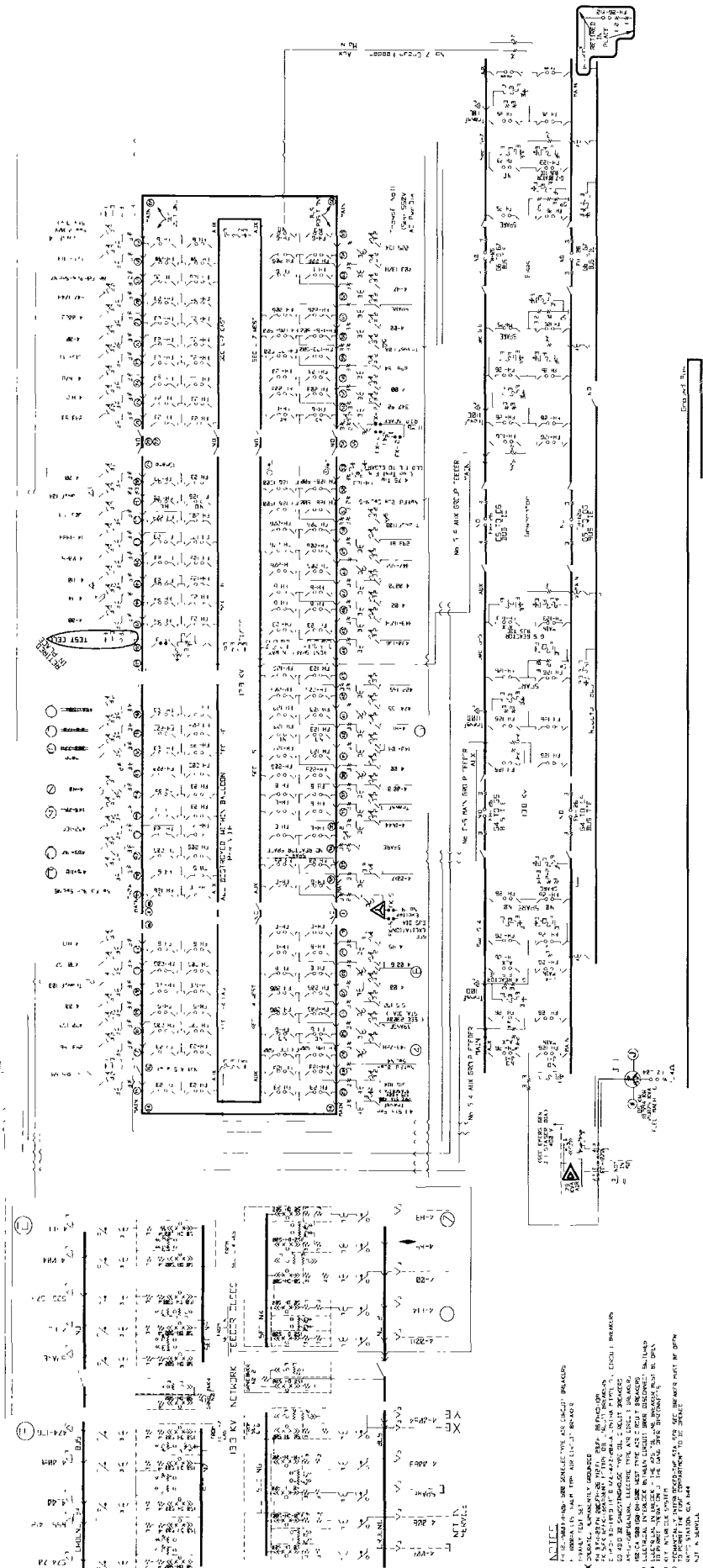
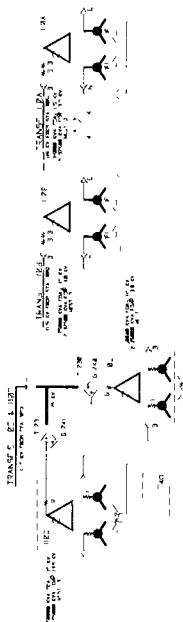
Both 110B Main 13.8kV Circuit Breakers

**Close:** Bus Tie Breakers operate normally open, manually close switches.  
Circuit Breakers #7 and #8 at Station 385 K Street to close ring bus

**Summary of Concerns: L Street**

1. Age and condition of L Street Substation equipment (**Part of the justification for the K Street Station #385D, Refer to K Street Station #385D**)





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## ***2004 T&D OPERATING STUDY MASS. AVENUE DISTRICT***

### **STATION #12 CHATHAM STREET**

Chatham Street Station #12 supplies all or parts of the Government Center, “Fanuel Hall” and North End regions of the City of Boston. In the summer of 2002 the Chatham Street Station #12 load was 93 MVA.

Chatham Street Station #12 consists of the following transformers:

Transformer #110A: McGraw-Edison 37.5 / 50 / 62.5 MVA 115 kV to 14.4 kV

Transformer #110B: McGraw-Edison 37.5 / 50 / 62.5 MVA 115 kV to 14.4 kV

Transformer #110C: McGraw-Edison 37.5 / 50 / 62.5 MVA 115 kV to 14.4 kV

Transformer #110D: McGraw-Edison 37.5 / 50 / 62.5 MVA 115 kV to 14.4 kV

Chatham Street Station #12 total capacity is 250 MVA. NSTAR employs summer emergency rating (cyclic capability) of 66.6 MVA for each of these transformer banks. The Mystic-K Street 115kV lines 250-516 and 250-517 supply Chatham Street Station #12. The outage of one of these transmission lines would result in the loss of two of Chatham Street transformers. The station has a firm capacity of 133 MVA. As a secondary network station there is no transfer switching capability to adjacent network stations. Chatham Street’s load carrying capability (i.e. firm capacity + transfer switching) is 133 MVA.

### **Overload Ratings:**

Transformer	Nameplate	12 hour LTE, 90F Ambient	12 hour LTE, 110F Ambient
110A	37.5/50/62.5 MVA	77 MVA	72 MVA
110B	37.5/50/62.5 MVA	77 MVA	72 MVA
110C	37.5/50/62.5 MVA	77 MVA	72 MVA
110D	37.5/50/62.5 MVA	77 MVA	72 MVA

### **Station Capabilities:**

Total Station Capacity (N)	Station Firm Capacity (LTE)	RADSEC Transfer	Manual Transfer	Total LCC
150 MVA	133 MVA*	0 MVA	0 MVA	133 MVA

\*Based upon loss of 110A, 110B and 250-516 line or 110C, 110D and 250-517 line.

### **2004-2008 Projected load:**

2004	2005	2006	2007	2008
112 MVA	113 MVA	114 MVA	118 MVA	123 MVA

### **Switching Actions:**

Loss of Transformer #110A, 110B and 250-516 Line

- Open:** OCB's 14 & 15 @ K Street  
Circuit Switcher CS770 and CS773  
Main 110A and 110B 13.8kV Secondary Circuit Breakers
- Close:** Nothing, bus ties operated closed  
Manually close OCB's 14 & 15 @ K Street  
Manually close CS773 and 110B 13.8 KV Secondary Breakers

Loss of Transformer #110B, 110A and 250-516 Line

- Open:** OCB's 14 & 15 @ K Street  
Circuit Switcher CS773 and CS770  
Main 110B and 110B 13.8kV Secondary Circuit Breaker
- Close:** Nothing, bus ties operated closed  
Manually close OCB's 14 & 15 @ K Street  
Manually close CS770 and 110A 13.8 KV Secondary Breakers

Loss of Transformer #110C, 110D and 250-517 Line

- Open:** OCB's 16 & 17 @ K Street  
Circuit Switcher CS774 and CS777  
Main 110C and 110D 13.8kV Secondary Circuit Breakers
- Close:** Nothing, bus ties operated closed  
Manually close OCB's 16 & 17 @ K Street  
Manually close CS777 and 110D 13.8 KV Secondary Breakers

Loss of Transformer #110D, 110C and 250-517 Line

- Open:** OCB's 16 & 17 @ K Street  
Circuit Switcher CS777 and CS774  
Main 110D and 110C 13.8kV Secondary Circuit Breaker
- Close:** Nothing, bus ties operated closed  
Manually close OCB's 16 & 17 @ K Street  
Manually close CS774 and 110C 13.8 KV Secondary Breakers

The descriptions above assume CS772 and CS776 are open at Chatham St.

**Summary of Concerns:**

1. Network feeder overloaded under contingency conditions (2005)
2. Upon the relief of Hawkins Street Sta #2 to Chatham Street Station #12 will be near the station's firm capacity (2008)

The Government Center, Fanuel, and North End region is a highly mixed area including office buildings, hotels, residential apartments and condominiums, retail shops, restaurants and entertainment that maintain a lively set of activities both day and evening. Much of the impetus for the continued development comes from the region's being a vibrant and economically active portion

of the city of Boston. The Mass General Hospital development will significantly increase the load within this region.

Based on load projections, by in the summer of 2008 for the contingency outage of two transformers, Chatham Street Station #12 will be heavily loaded at 95% of the firm capacity. A load transfer of 5-10 MVA from Hawkins Street Station #2 to Chatham Street Station #12 would increase the loading on Chatham Street Sta #12 to 96%-100% of firm capacity.

### Distribution Systems

#### DSS Lines

Chatham Station #12 supplies the Central Artery Vent Building #4 line group.

The **Central Artery Vent Building Line Group** consists of DSS lines 502-1254 and 501-1274. The line group supplies Central Artery Customer Station #502, Vent Building #4. Upon the loss of either DSS line, the remaining DSS line will not exceed the long-term emergency capacity (LTE), based on 2004-2008 peak load projections.

DSS Line	% of Normal 2004	LTE - % Load at Risk 2004	MVA at Risk 2004	LTE - % Load at Risk 2008	MVA at Risk 2008
502-1254	56%	0%	0	0%	0
502-1274	56%	0%	0	0%	0

#### 14 kV Network Feeders

There are twenty-three network feeders supplied from Chatham Station #12. By the summer 2005 network feeder 12-1N31S will be heavily loaded exceeding 90% of normal rating. The following table summarized the performance of the network feeders.

14kV Network Lines	% of Normal 2002	Projected % of Normal 2004	Projected % of Normal 2008
12-1N11S	36%	44%	48%
12-1N12N	40%	48%	53%
12-1N13W	58%	70%	77%
12-1N21S	67%	81%	88%
12-1N22N	41%	49%	54%
12-1N23W	68%	81%	89%
12-1N31S	73%	88%	97%
12-1N32N	54%	65%	72%
12-1N33W	22%	27%	29%
12-1N41S	63%	76%	83%
12-1N42N	42%	51%	56%
12-1N43W	54%	65%	72%
12-1N44N	60%	72%	79%
12-1N51S	40%	48%	53%
12-1N52N	33%	40%	44%
12-1N53W	54%	66%	72%
12-1N61S	44%	53%	58%

12-1N62N	50%	60%	66%
12-1N71S	54%	65%	71%
12-1N72N	56%	68%	75%
12-1N73W	31%	37%	41%
12-1N81S	58%	70%	77%
12-1N82N	64%	78%	85%

***Loading on Chatham Street Network Feeders.***

**Proposed Integrated Plan**

Chatham Street Station #12 has approximately 10 MVA of spare transformer capacity and several spare feeder positions to support load growth. The plan would be to cut-over (i.e. transfer) small segments of the Secondary Network Vaults and/or Tertiary Network Vaults within the Beacon Hill/Government Center supplied by Hawkins Street Station #2 to Chatham Street Station #12. This solution would transfer up to 5-10 MVA of load from Hawkins Street Station #12 to Chatham Street Station #12 and reduce the loading of Chatham Street Station #21 to 96%-100% of the firm capacity.

The heavy loading conditions on the network feeders will be addressed by extending and reconductoring feeders within the network.

<b>Action</b>	<b>Year needed</b>	<b>Cost</b>
Reconductor feeder section of 12-1N31S	2005	\$100 K



## ***2004 T&D OPERATING STUDY MASS. AVENUE DISTRICT***

### **STATION #53 HIGH STREET**

High Street Station #53 supplies all or parts of the Financial, South Station districts and the downtown Boston Waterfront region of the City of Boston. In the summer of 2002 the High Street Station #12 load was 87 MVA.

Prior to the 2003 summer cut-over (i.e. transfer) the Secondary Network Vaults and Tertiary Network Vaults within the Leather District presently supplied from Kingston Street Station #514N to High Street Station #53. This project transferred 18 MVA of load from Kingston Street Station #514N to High Street Station #53 and restores the Leather district to its original (i.e. pre-Central Artery) distribution network configuration and station supply. The cost of this work was reimbursed by the Central Artery project. The load transfer from Kingston Street Station #514N to High Street Station #53 will increase the Financial, South Station districts and the downtown Boston Waterfront region's load by 18 MVA.

High Street Station #53 consists of the following transformers:

Transformer #110A: General Electric 37.5 / 50 / 62.5 MVA 117 kV to 14.4 kV

Transformer #110B: General Electric 37.5 / 50 / 62.5 MVA 117 kV to 14.4 kV

Transformer #110C: General Electric 37.5 / 50 / 62.5 MVA 117 kV to 14.4 kV

Transformer #110D: General Electric 37.5 / 50 / 62.5 MVA 117 kV to 14.4 kV

High Street Station #53 total capacity is 250 MVA. NSTAR employs summer emergency rating (cyclic capability) of 69.4 MVA for each of these transformer banks. The Kingston-K Street 115kV lines 385-510 and 385-511 supply High Street Station #53. The outage of one of these transmission lines would result in the loss of two of High Street transformers. The station has a firm capacity of 139 MVA. As a secondary network station there is no transfer switching capability to adjacent network stations. High Street's load carrying capability (i.e. firm capacity + transfer switching) is 139 MVA.

### **Overload Ratings:**

Transformer	Nameplate	12 hour LTE, 90F Ambient	12 hour LTE, 110F Ambient
110A	37.5/50/62.5 MVA	80 MVA	75 MVA
110B	37.5/50/62.5 MVA	80 MVA	75 MVA
110C	37.5/50/62.5 MVA	80 MVA	75 MVA
110D	37.5/50/62.5 MVA	80 MVA	75 MVA

### **Station Capabilities:**

Total Station Capacity (N)	Station Firm Capacity (LTE)	RADSEC Transfer	Manual Transfer	Total LCC
150 MVA	139 MVA*	0 MVA	0 MVA	139 MVA

\* Based upon loss of 110A, 110B and 385-510 line or 110C, 110D and 385-511 line.

**2004-2008 Projected load:**

2004	2005	2006	2007	2008
108 MVA	109 MVA	110 MVA	110 MVA	111 MVA

**Switching Actions:**

Loss of Transformer #110A also isolates the 385-510 Line, 110B and the 110A @ Kingston St

- Open:** OCB's 10 & 11 @ K Street  
 OCB's 8 & 9 @ Kingston St  
 Circuit Switcher CS771 (110A) @ Kingston St  
 Circuit Switcher CS770 and CS773  
 Main 110A and 110B 13.8kV Secondary Circuit Breakers
- Close:** Nothing, bus ties operated closed  
 Manually close OCB's 10 & 11 @ K Street  
 Manually close OCB's 8 & 9 @ Kingston St  
 Manually close CS771 and restore transformer 110A @ Kingston St  
 Manually close CS773 and restore transformer 110B @ High St

Loss of Transformer #110B also isolates the 385-510 Line, 110A and the 110A @ Kingston St

- Open:** OCB's 10 & 11 @ K Street  
 OCB's 8 & 9 @ Kingston St  
 Circuit Switcher CS771 (110A) @ Kingston St  
 Circuit Switcher CS773 and CS771  
 Main 110B and 110A 13.8kV Secondary Circuit Breaker
- Close:** Nothing, bus ties operated closed  
 Manually close OCB's 10 & 11 @ K Street  
 Manually close OCB's 8 & 9 @ Kingston St  
 Manually close CS771 and restore transformer 110A @ Kingston St  
 Manually close CS771 and restore transformer 110A @ High St

Loss of Transformer #110C also isolates the 385-511 Line, 110D and the 110B @ Kingston St

- Open:** OCB's 17 & 18 @ K Street  
 OCB's 6, 10 & 11 @ Kingston St  
 Circuit Switcher CS770 (110B) @ Kingston St  
 Circuit Switcher CS774 and CS777  
 Main 110C and 110D 13.8kV Secondary Circuit Breaker
- Close:** Nothing, bus ties operated closed  
 Manually close OCB's 17 & 18 @ K Street  
 Manually close OCB's 6, 10 & 11 @ Kingston St  
 Manually close CS770 and restore transformer 110B @ Kingston St  
 Manually close CS777 and restore transformer 110D @ High St



Loss of Transformer #110D also isolates the 385-511 Line, 110C and the 110B @ Kingston St

**Open:** OCB's 17 & 18 @ K Street

OCB's 6, 10 & 11 @ Kingston St

Circuit Switcher CS770 (110B) @ Kingston St

Circuit Switcher CS777 and CS774

Main 110D and 110C 13.8kV Secondary Circuit Breaker

**Close:** Nothing, bus ties operated closed

Manually close OCB's 17 & 18 @ K Street

Manually close OCB's 6, 10 & 11 @ Kingston St

Manually close CS770 and restore transformer 110B @ Kingston St

Manually close CS774 and restore transformer 110C @ High St

### **Summary of Concerns:**

1. Network feeders overloaded under contingency conditions (2004-2006)

Without any significant major development projects during 2002-2008, the High Street Supply region is projected to experience meager load growth; approximately 0.7% annual load growth. As a result of this small load growth based on the existing load forecast, the High Street Station #53 will support the forecasted load growth in the supply region through 2008. In the summer of 2008 for the contingency outage of two transformers, High Street Station #53 will be loaded at 80% of the firm capacity.

### **Distribution System**

#### **14 kV Network Feeders**

There are twenty-four network feeders supplied from High Street Station #53. By the summer 2004 most of the network feeders supplying the east grid will be heavily loaded exceeding 90% of normal rating. Three of the east grid feeders, 53-1N23E, 1N52E and 1N81E will exceed 100% of normal ratings. The following table summarized the performance of the network feeders.

<b>14kV Network Lines</b>	<b>% of Normal 2002</b>	<b>Projected % of Normal 2004</b>	<b>Projected% of Normal 2008</b>
53-1N11E	64%	66%	102%
53-1N12E	64%	66%	68%
53-1N13W	57%	59%	61%
53-1N21	21%	50%	51%
53-1N22E	73%	75%	77%
53-1N23E	103%	106%	109%
53-1N31S	26%	53%	54%
53-1N32E	18%	18%	19%
53-1N33W	18%	18%	19%
53-1N41S	23%	54%	55%
53-1N42E	27%	27%	78%
53-1N43W	27%	27%	78%
53-1N51S	23%	61%	62%
53-1N52E	104%	107%	110%

53-1N53W	47%	49%	50%
53-1N61S	19%	49%	51%
53-1N62E	75%	77%	79%
53-1N63W	46%	47%	48%
53-1N71S	32%	85%	87%
53-1N72E	89%	43 1/2%	43 1/2%
53-1N73W	62%	64%	66%
53-1N81S	15%	15%	16%
53-1N81E	114%	117%	121%
53-1N82W	17%	17%	18%

***Loading on High Street Network Feeders.***

**Proposed Integrated Plan**

High Street Station #53 has approximately 18 MVA of spare transformer capacity and several spare feeder positions to support load growth. The heavy loading conditions on the network feeders especially supplying the east grid within the High Street Station #53 network will be addressed by extending and reconductoring feeders within the network.

<b>Action</b>	<b>Year needed</b>	<b>Cost</b>
Reconductor feeder section of 53-1N11E	2004	\$25K
Reconductor and reconfigure 53-1N32E	2004	\$150K
Reconductor the feeder section of 53-1N71S	2005	TBD
Reconductor and Reconfigure 53-1N42E	2006	TBD

2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, 54, 55, 56, 57, 58, 59, 60, 61, 62, 63, 64, 65, 66, 67, 68, 69, 70, 71, 72, 73, 74, 75, 76, 77, 78, 79, 80, 81, 82, 83, 84, 85, 86, 87, 88, 89, 90, 91, 92, 93, 94, 95, 96, 97, 98, 99, 100, 101, 102, 103, 104, 105, 106, 107, 108, 109, 110, 111, 112, 113, 114, 115, 116, 117, 118, 119, 120, 121, 122, 123, 124, 125, 126, 127, 128, 129, 130, 131, 132, 133, 134, 135, 136, 137, 138, 139, 140, 141, 142, 143, 144, 145, 146, 147, 148, 149, 150, 151, 152, 153, 154, 155, 156, 157, 158, 159, 160, 161, 162, 163, 164, 165, 166, 167, 168, 169, 170, 171, 172, 173, 174, 175, 176, 177, 178, 179, 180, 181, 182, 183, 184, 185, 186, 187, 188, 189, 190, 191, 192, 193, 194, 195, 196, 197, 198, 199, 200, 201, 202, 203, 204, 205, 206, 207, 208, 209, 210, 211, 212, 213, 214, 215, 216, 217, 218, 219, 220, 221, 222, 223, 224, 225, 226, 227, 228, 229, 230, 231, 232, 233, 234, 235, 236, 237, 238, 239, 240, 241, 242, 243, 244, 245, 246, 247, 248, 249, 250, 251, 252, 253, 254, 255, 256, 257, 258, 259, 260, 261, 262, 263, 264, 265, 266, 267, 268, 269, 270, 271, 272, 273, 274, 275, 276, 277, 278, 279, 280, 281, 282, 283, 284, 285, 286, 287, 288, 289, 290, 291, 292, 293, 294, 295, 296, 297, 298, 299, 300, 301, 302, 303, 304, 305, 306, 307, 308, 309, 310, 311, 312, 313, 314, 315, 316, 317, 318, 319, 320, 321, 322, 323, 324, 325, 326, 327, 328, 329, 330, 331, 332, 333, 334, 335, 336, 337, 338, 339, 340, 341, 342, 343, 344, 345, 346, 347, 348, 349, 350, 351, 352, 353, 354, 355, 356, 357, 358, 359, 360, 361, 362, 363, 364, 365, 366, 367, 368, 369, 370, 371, 372, 373, 374, 375, 376, 377, 378, 379, 380, 381, 382, 383, 384, 385, 386, 387, 388, 389, 390, 391, 392, 393, 394, 395, 396, 397, 398, 399, 400, 401, 402, 403, 404, 405, 406, 407, 408, 409, 410, 411, 412, 413, 414, 415, 416, 417, 418, 419, 420, 421, 422, 423, 424, 425, 426, 427, 428, 429, 430, 431, 432, 433, 434, 435, 436, 437, 438, 439, 440, 441, 442, 443, 444, 445, 446, 447, 448, 449, 450, 451, 452, 453, 454, 455, 456, 457, 458, 459, 460, 461, 462, 463, 464, 465, 466, 467, 468, 469, 470, 471, 472, 473, 474, 475, 476, 477, 478, 479, 480, 481, 482, 483, 484, 485, 486, 487, 488, 489, 490, 491, 492, 493, 494, 495, 496, 497, 498, 499, 500, 501, 502, 503, 504, 505, 506, 507, 508, 509, 510, 511, 512, 513, 514, 515, 516, 517, 518, 519, 520, 521, 522, 523, 524, 525, 526, 527, 528, 529, 530, 531, 532, 533, 534, 535, 536, 537, 538, 539, 540, 541, 542, 543, 544, 545, 546, 547, 548, 549, 550, 551, 552, 553, 554, 555, 556, 557, 558, 559, 560, 561, 562, 563, 564, 565, 566, 567, 568, 569, 570, 571, 572, 573, 574, 575, 576, 577, 578, 579, 580, 581, 582, 583, 584, 585, 586, 587, 588, 589, 590, 591, 592, 593, 594, 595, 596, 597, 598, 599, 600, 601, 602, 603, 604, 605, 606, 607, 608, 609, 610, 611, 612, 613, 614, 615, 616, 617, 618, 619, 620, 621, 622, 623, 624, 625, 626, 627, 628, 629, 630, 631, 632, 633, 634, 635, 636, 637, 638, 639, 640, 641, 642, 643, 644, 645, 646, 647, 648, 649, 650, 651, 652, 653, 654, 655, 656, 657, 658, 659, 660, 661, 662, 663, 664, 665, 666, 667, 668, 669, 670, 671, 672, 673, 674, 675, 676, 677, 678, 679, 680, 681, 682, 683, 684, 685, 686, 687, 688, 689, 690, 691, 692, 693, 694, 695, 696, 697, 698, 699, 700, 701, 702, 703, 704, 705, 706, 707, 708, 709, 710, 711, 712, 713, 714, 715, 716, 717, 718, 719, 720, 721, 722, 723, 724, 725, 726, 727, 728, 729, 730, 731, 732, 733, 734, 735, 736, 737, 738, 739, 740, 741, 742, 743, 744, 745, 746, 747, 748, 749, 750, 751, 752, 753, 754, 755, 756, 757, 758, 759, 760, 761, 762, 763, 764, 765, 766, 767, 768, 769, 770, 771, 772, 773, 774, 775, 776, 777, 778, 779, 780, 781, 782, 783, 784, 785, 786, 787, 788, 789, 790, 791, 792, 793, 794, 795, 796, 797, 798, 799, 800, 801, 802, 803, 804, 805, 806, 807, 808, 809, 810, 811, 812, 813, 814, 815, 816, 817, 818, 819, 820, 821, 822, 823, 824, 825, 826, 827, 828, 829, 830, 831, 832, 833, 834, 835, 836, 837, 838, 839, 840, 841,

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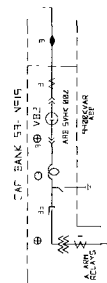
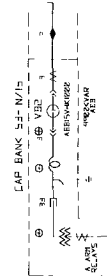
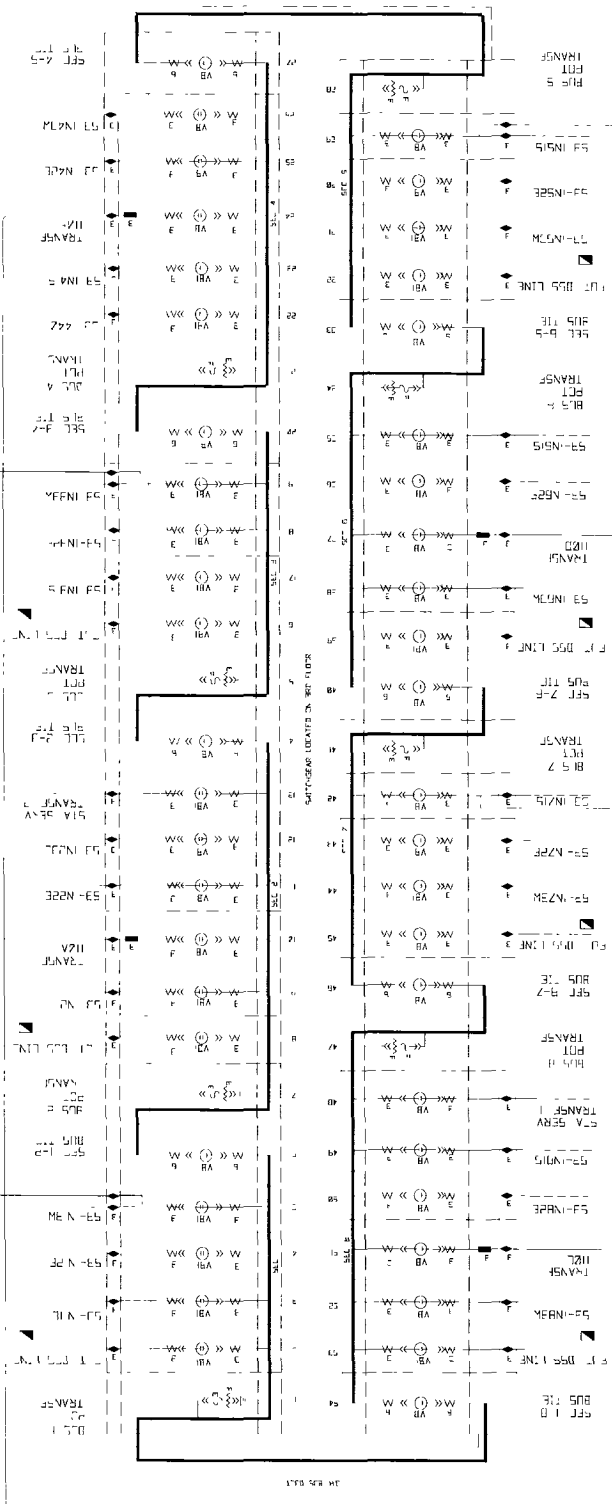
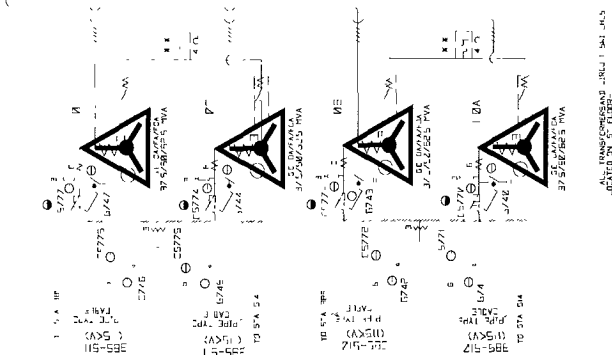
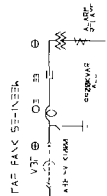
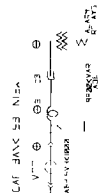
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## ***2004 T&D OPERATING STUDY MASS. AVENUE DISTRICT***

### **STATION #71 CARVER STREET**

Carver Street Station #71 supplies all or parts of the Back Bay and Theater District regions of the City of Boston. In the summer of 2002 the Carver Street Station #71 load was 74 MVA

Carver Street Station #71 consists of the following transformers:

Transformer #110A: Westinghouse 75 / 84 MVA 110 kV to 13.8/13.8 kV

Transformer #110B: Westinghouse 75 / 84 MVA 110 kV to 13.8/13.8 kV

Carver Street Station #71 total capacity is 168 MVA. NSTAR employs summer emergency rating (cyclic capability) of 87 MVA for each of these transformer banks. The station has a firm capacity of 87 MVA. As a secondary network station there is no transfer switching capability to adjacent network stations. Carver Street's load carrying capability (i.e. firm capacity + transfer switching) is 87 MVA.

### **Overload Ratings:**

Transformer	Nameplate	12 hour LTE, 90F Ambient	12 hour LTE, 110F Ambient
110A	75 / 84 MVA	100 MVA	94 MVA
110B	75 / 84 MVA	100 MVA	94 MVA

### **Station Capabilities:**

Total Station Capacity (N)	Station Firm Capacity (LTE)	RADSEC Transfer	Manual Transfer	Total LCC
150 MVA	87 MVA*	0 MVA	0 MVA	87 MVA

\*Based upon loss of either 110A/329-512 or 110B/329-513.

### **2004-2008 Projected load:**

2004	2005	2006	2007	2008
83 MVA	84 MVA	85 MVA	86 MVA	88 MVA

### **Switching Actions:**

Loss of Transformer #110A also isolates the 329-512 Line and 110A @ Scotia St

**Open:** OCB's 1 & 2 @ Kingston St  
 OCB's 3 & 6 @ Brighton  
 Circuit Switcher CS771 @ Scotia St  
 Circuit Switcher CS771

Both 110A 13.8kV Secondary Circuit Breakers

**Close:** The ABR scheme closes the normally open section #1 tie breaker.

Manually close OCB's 1 & 2 @ Kingston St

Manually close OCB's 3 & 6 @ Brighton

Manually close CS771 and restore 110A @ Scotia St

Loss of Transformer #110B also isolates the 329-513 Line and 110B @ Scotia St

**Open:** OCB's 4 & 5 @ Kingston St

OCB's 9 & 12 @ Brighton

Circuit Switcher CS770 @ Scotia St

Circuit Switcher CS770

Both 110B 13.8kV Secondary Circuit Breakers

**Close:** The ABR scheme closes the normally open section #1 tie breaker.

Manually close OCB's 4 & 5 @ Kingston St

Manually close OCB's 9 & 12 @ Brighton

Manually close CS770 and restore 110B @ Scotia St

### **Summary of Concerns:**

1. Network feeders overloaded under contingency conditions (2004-2008)
2. Carver Street Station #71 is overloaded under contingency conditions (2008)

The Back Bay/Theater districts continue to evolve through various development stages. The region is a highly mixed area including office buildings, hotels, residential apartments and condominiums, retail shops, restaurants and entertainment that maintain a lively set of activities both day and evening. Much of the impetus for the continued development comes from the region's being a vibrant and economically active portion of the city of Boston. The anticipated development will increase the load within this region.

Based on load projections, by in the summer of 2008 for a single-contingency outage of either transformer 110A or 110B, Carver Street Station #71 will exceed the firm capacity. The new load will strain the capability of Carver Street #71's substation and distribution infrastructure to support the customer load requirements. Since Carver Street Station #71 is a secondary network station the load at risk is the entire station 88 MVA.

### **Distribution System**

#### **14 kV Network Feeders**

There are twenty network feeders supplied from Carver Street Station #71. By the summer 2004 network feeders 71-1N11 and 71-1N12 will exceed the 100% normal rating and four other feeders will be heavily loaded exceeding 90% of normal rating. The following table summarized the performance of the network feeders.

<b>14kV Network Lines</b>	<b>% of Normal 2002</b>	<b>Projected % of Normal 2004</b>	<b>Projected% of Normal 2008</b>
71-1N11	97%	103%	109%
71-1N12	99%	101%	107%
0.71-1N13	4%	4%	5%

71-1N14	87%	92 3/4%	104%
71-1N15	16%	18%	19%
71-1N21	72%	80%	85%
71-1N22	64%	71%	76%
71-1N23	73%	82%	87%
71-1N24	58%	65%	69%
71-1N25	12%	13%	14%
71-1N31	62%	69%	74%
71-1N32	14%	16%	17%
71-1N33	61%	68%	72%
71-1N34	88%	93 3/4%	104%
71-1N35	55%	62%	66%
71-1N41	5%	5%	5%
71-1N42	83%	87 3/4%	93 3/4%
71-1N43	89%	94 3/4%	105%
71-1N44	57%	64%	68%
71-1N45	64%	72%	76%

**Loading on Carver Street Network Feeders.**

**Proposed Integrated Plan**

The development of either a new Back Bay Network 115/14 kV station or the upgrade of Carver Street Station #71 by replacing the existing transformers 110A and 110B with new larger 75/100/125 MVA transformers and the installation of new distribution switchgear will provide capacity to relieve Carver Street Station #71.

The heavy loading conditions on the network feeders will be addressed by extending and reconductoring feeders within the network.

Action	Year needed	Cost
Extend 71-1N41	2004	\$150K
Extend 71-1N13 to relieve 71-1N11 and 71-1N13.	2004	\$170K
Reconductor 71-1N12	2004	\$25K
Reconductor and Reconfigure 71-1N43	2006	TBD
Reconductor and Reconfigure 71-1N42	2008	TBD
New Back Bay 115/14kV station or replace the Carver Street Sta #71 transformers with new larger transformers.	2008	TBD



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## ***2004 T&D OPERATING STUDY MASS. AVENUE DISTRICT***

### **STATION #106 ANDREW SQUARE**

Andrew Square Station 106 serves a power supply area consisting of the City of Boston neighborhoods of Mission Hill, Roxbury, the South End and portions of South Boston. During the summer of 2002, Andrew Square Station 106 peak load was 142 MVA, 25 MVA of load will be transferred to the new K Street Station 385D by summer 2004.

Andrew Square Station 106 consists of five 115/14 kV transformers.

- Transformer #110A: Cooper Power Systems 24 / 32 / 44.5 MVA 117 kV to 14.4 kV
- Transformer #110B: Cooper Power Systems 24 / 32 / 44.5 MVA 117 kV to 14.4 kV
- Transformer #110C: Cooper Power Systems 24 / 32 / 44.5 MVA 117 kV to 14.4 kV
- Transformer #110D: Cooper Power Systems 24 / 32 / 44.5 MVA 117 kV to 14.4 kV
- Transformer #110E: Pennsylvania 30/40/44.8 MVA 117 kV to 14.4 kV (in service spare)

Andrew Square Station 106 total capacity is 178 MVA. NSTAR employs summer emergency rating (cyclic capability) of 133.5 MVA. There is no transfer switching to adjacent substations. Due to a transmission constraint on 483-524/525 Andrew Square's load carrying capability is limited to 130 MVA.

### **Overload Ratings:**

Transformer	Nameplate	12 hour LTE, 90F Ambient	12 hour LTE, 110F Ambient
110A	24/32/44.5 MVA	44.5 MVA	44.5 MVA
110B	24/32/44.5 MVA	44.5 MVA	44.5 MVA
110C	24/32/44.5 MVA	44.5 MVA	44.5 MVA
110D	24/32/44.5 MVA	44.5 MVA	44.5 MVA

### **Station Capabilities:**

Total Station Capacity (N)	Station Firm Capacity (LTE)	RADSEC Transfer	Manual Transfer	Total LCC
178 MVA	133.5 MVA*	0 MVA	0 MVA	130 MVA**

\*Based upon loss of one transformer and activation of the 115 KV restoral scheme.

\*\*The load carrying capability (LCC) is limited due to an n-1 constraint on transmission lines 483-524/525.

### **Station Load Forecast:**

2004	2005	2006	2007	2008
134 MVA	135 MVA	136 MVA	139 MVA	141 MVA

### **Switching Actions:**

Loss of Transformer #110A:



**Open:** OCB #1 (OCB #2 is normally open)  
Circuit Switcher CS770  
Main 110A 13.8kV Secondary Circuit Breaker  
**Close:** ABR scheme closes 13.8 KV bus ties  
Manually close OCB #1

Loss of Transformer #110B:

**Open:** OCB #3 (OCB #2 is normally open)  
Circuit Switcher CS771  
Main 110B 13.8kV Secondary Circuit Breaker  
**Close:** ABR scheme closes 13.8 KV bus ties  
Manually close OCB #3

Loss of Transformer #110C, 483-525 Line and 110B @ Dewar St

**Open:** OCB's 4 & 7 @ K Street  
CS770 @ Dewar St (110B transformer)  
OCB #1  
Circuit Switcher CS772  
Main 110C 13.8kV Secondary Circuit Breaker  
**Close:** ABR scheme closes 13.8 KV bus ties  
115 KV ABR scheme closes OCB #2  
ABR scheme closes 13.8 KV bus ties @ Dewar St.  
Manually close OCB's 4 & 7 @ K Street.  
Manually close CS770 and restore 110B @ Dewar St

Loss of Transformer #110D, 483-524 Line and 110A @ Dewar St

**Open:** OCB's 13 & 14 @ K Street  
CS771 @ Dewar St (110A transformer)  
OCB #3  
Circuit Switcher CS774  
Main 110D 13.8kV Secondary Circuit Breaker  
**Close:** ABR scheme closes 13.8 KV bus ties  
115 KV ABR scheme closes OCB #2  
ABR scheme closes 13.8 KV bus ties @ Dewar St  
Manually close OCB's 13 & 14 @ K Street  
Manually close CS771 and restore 110A @ Dewar St

**Summary of Concerns: Andrew Square Region**

For any transformer outage, remaining in-service transformers carry full station load of 134.0 MVA. Total firm transformation of 133.5 MVA is exceeded by less than 1%, with approximately 0.50 MW of load at risk of load shed for loss of a transformer. For the loss of either transmission line 483-524 or 525 Andrew Square's load carrying capability of 130 MVA is exceed by 3%, with approximately 4 MW of load at risk of load shedding. There is no transfer capability with any other station from Station 106 Andrew Square.

**Transmission:**

1. Loss of one of the K Street – Andrew Square – Dewar Lines (483-524/525) will exceed the LTE limit of the remaining line starting in 2004.

**Distribution:**

1. Inadequate load carry capability, n-1 transmission limitation (2004)
2. Roxbury Network line group overloaded under contingency conditions (2004)
3. Humboldt Avenue line group overloaded under contingency (2004)
4. Veterans Hospital line group overloaded under contingency (2004)
5. South End line group overloaded under contingency (2004)
6. Boston University line group overloaded under contingency (2008)

**Distribution Systems**

***DSS Lines***

- The Roxbury Network line group is composed of DSS lines 399-119, 106-1N31H, 106-1N29H, 106-1N28H, and 106-1N18H. This line group supplies Roxbury neighborhoods via NSTAR primary network units 8, 9, 16 and 21 and direct 13.8kV distribution the Roxbury area. Upon the loss of lines 399-119, 106-1N31H, 106-1N28H, and 106-1N18H, one or more of the remaining lines will exceed its long-term emergency capacity (LTE), based on the 2004 forecast.
- The Humboldt line group is composed of DSS lines 143-76H, 143-75H, 143-151H and 143-109H. This line group serves supplies the Roxbury neighborhoods adjacent to Franklin Park via NSTAR Station 143 and direct 13.8kV distribution. Upon the loss of 143-76H and 143-151H, the one or more of the remaining lines will exceed their long-term emergency capacity (LTE), based on the 2004 forecast.
- The South End line group is composed of DSS lines 528-169H, 318-97, 318-174H, 318-173H, and 318-129H. This line group serves supplies the South End section of Boston via NSTAR Station 318 and direct 13.8kV distribution. Upon the loss of 528-169H, 318-97, 318-174H, and 318-129H, one or more of the other lines will exceed their long-term emergency capacity (LTE), this is based on 2004 forecast.
- The Veterans Hospital line group is composed of lines 304-150H and 304-77H. The line group supplies the Jamaica Plain US Veterans Hospital and the New England Baptist Hospital, and was found to N-1 supply issues in 2004 with the loss of 305-150H.
- The Boston University Medical line group is composed of lines 464-168H and 464-170H. The line group supplies the Albany Street Boston Medical Center in Roxbury, and was found to have N-1 supply issues in 2008 with the loss of 464-168H.

See the table below listing the loading of DSS lines in the Andrew Square area.

<b>DSS Line</b>	<b>% of Normal 2004</b>	<b>LTE - % Load at Risk 2004</b>	<b>MVA at Risk 2004</b>	<b>LTE - % Load at Risk 2008</b>	<b>MVA at Risk 2008</b>
399-119	94%	8%	0.5	15%	1.0
106-1N31H	54%	15%	0.6	27%	1.1
106-1N29H	108%	0%	0	0%	0
106-1N28H	75%	8%	0.3	18%	0.8
106-1N18H	78%	28%	1.2	38%	1.8
143-76H	82%	32%	1.9	40%	1.0
143-75H	124%	0%	0	0%	0
143-151H	85%	82%	5.9	88%	6.7
143-109H	80%	0%	0	0%	0
528-169H	69%	2%	0.1	10%	0.6
318-97H	76%	10%	1.0	18%	1.0
318-174H	75%	2%	0.1	15%	1.0
318-173H	97%	0%	0	0%	0
318-129H	91%	0%	0	7%	0.4
304-77H	67%	0%	0	0%	0
304-150H	77%	3%	0.2	11%	0.8
464-170H	50%	0%	0	0%	0
464-168H	72%	0%	0	15%	1.4

*Loading on Andrew Square DSS lines.*

#### **14kV Distribution**

The 14kV distribution out of Andrew Square Station 106 is projected to have adequate capacity through 2008.

<b>14 kV Radial Line</b>	<b>% of Normal 2002</b>	<b>Projected % of Normal 2004</b>	<b>Projected % of Normal 2008</b>
106-H1	4%	24%	65%
106-H2	71%	73%	77%
106-H3	68%	70%	74%
106-H4	64%	66%	69%

*Loading on Andrew Square 14kV radial lines.*

#### **4kV Substation**

Andrew Square Station 106 feeds three 4 kV stations and the Roxbury Network made up of four primary network units (PNU): The 4kV Stations: Humboldt Avenue Station 143, South End Station 318, Southampton Street Station 323 and the Roxbury Primary Network. The loads at three of the four 4kV stations supplied by Andrew Square Station 106 are projected to decrease because of on-going 4kV conversions. The 4kV conversions are addressing reliability and community concerns in the areas served by these stations. The conversions of the Humboldt Avenue Station 143 and Southampton Street Station 323 circuits will correct the heavy loading on the station transformers. The table below summarizes the capacity of these 4 kV stations.

<b>4 kV Station</b>	<b>2002 Peak (MVA)</b>	<b>LTE Capacity (MVA)</b>	<b>2004 Projection (MVA)</b>	<b>2008 Projection (MVA)</b>
Station 143	8.9	8.4	7.2	4.7

Station 318	18	21.1	16.2	16.9
Station 323	6.1	6.0	5.7	6.0
Roxbury Network	8.5	18.0	8.6	9.0

*Loading on 4 kV stations fed from Andrew Square Station 106*

### **Proposed Integrated Plan**

The suggested actions listed in the table below will address all of the capacity concerns in the region.

The new K Street Substation with a final completion date of June 2004 and the proposed Colburn Street Substation will have a significant impact on the substation and distribution capacity in the Andrew Square supply area. The substation and associated distribution infrastructure will address all of the Andrew Square supply area capacity needs for the next 5 years. The new stations will be developed to provide expanded distribution and substation capacity to supply Andrew Square area loads within City of Boston neighborhoods of Jamaica Plain, Roxbury, South End and South Boston.

The station relief provided by the new K and Colburn Street substations will provide the Andrew Square Station with adequate substation capacity to need the area's capacity requirements through 2008. The Andrew Square station relief will also alleviate the n-1 transmission over load condition on the K Street – Andrew Square – Dewar Lines (483-524/525). The Colburn Street project will address capacity issues on the Roxbury Network, Humboldt Avenue, Boston University Medical and the South End line groups. New distribution circuit capacity will be install into the three line group areas. The new distribution circuits will also create transfer capabilities between Andrew Square Station 106 and the new Colburn Street Station 350, allowing for increased substation transformer utilization. The Jamaica Plain Veterans Hospital line group will be re-supplied by Colburn Street Station, correcting an n-1 supply issue.

#### **Action**

**Year  
needed**

**Estimated  
Cost**

⇒ **New Colburn Street Substation see Brighton Station 329 Area**

**2004 - 05**

*Recommended course of action for the Andrew Square Region*



## ***2004 T&D OPERATING STUDY MASS. AVENUE DISTRICT***

### **STATION #110 BAKER STREET**

Baker Street Station 110 serves a power supply area consisting of West Roxbury, Dedham, and parts of Canton, Newton, and Westwood. Baker Street Station 110 consists of two 115/13.8 kV step-down transformers:

Transformer #110A: Westinghouse 75 MVA 110 / 66 / 24.4 kV

Transformer #110B: Westinghouse 75 MVA 110 / 66 / 24.4 kV

Baker Street Station 110 total capacity is 150 MVA. NSTAR employs summer emergency rating (cyclic capability) of 89 MVA for each of these two banks. Station 110's firm capacity is 89 MVA. Baker Street Station 110 has approximately 12.5 MVA of transfer switching to Stations 470 Canton and 148 Needham through the 24kV DSS system via Dedham Station 20. Baker Street's load carrying capability is 101.5 MVA.

### **Overload Ratings:**

Transformer	Nameplate	12 hour LTE, 90F Ambient	12 hour LTE, 110F Ambient
110A	75 MVA	113 MVA	106 MVA
110B	75 MVA	103 MVA	96 MVA

### **Station Capabilities:**

Total Station Capacity (N)	Station Firm Capacity (LTE)	RADSEC Transfer	Manual Transfer	Total LCC
150 MVA	89 MVA	12.5 MVA	0 MVA	101.5 MVA

### **Station Load Forecast:**

2004	2005	2006	2007	2008
83 MVA	83 MVA	84 MVA	85 MVA	87 MVA

### **Switching Actions:**

#### **Loss of Transformer #110A:**

**Open:** Circuit Breakers #8 and #9

Main 24kV Circuit Breaker #6

Disconnect Switch #T730

**Close:** Nothing on 24kV side, bus ties normally operated closed.  
Circuit Breakers #8 and #9 to close 115kV ring.

**Loss of Transformer #110B:**

**Open:** Circuit Breakers #11 and #12

Main 24kV Circuit Breaker #9

Disconnect Switch #T731

**Close:** Nothing on 24kV side, bus ties normally operated closed.  
Circuit Breakers #11 and #12 to close 115kV ring.

**Transfer Switching:**

While not required for the loss of either transformer, the transfer of the following circuits via RADSEC switches may also be conducted for load relief:

Dedham 20-H3 to Canton 470-H1 via RADSEC MRU and Station breaker at Dedham Station #20 for a transfer of 6.0 MVA.

Dedham 20-H6 to Needham 148-H6 via RADSEC MRU and RADSEC MRU for a transfer of 2.0 MVA.

Dedham 20-H1 to Needham 148-H3 via RADSEC MRU and Station breaker at Dedham Station #20 for a transfer of 4.5 MVA.

Total Transfer: 12.5 MVA

**Summary of Concerns: Baker Street Region**

For any transformer outage, the remaining in-service transformer carries the full station load of 83.0 MVA. The station has 15 MVA of transfer capability to Stations 470 Canton and 148 Needham through the 24kV DSS system via Station 20 Dedham.

Without any significant major development projects during 2004-2008, the Baker Street Supply region is projected to experience modest load growth, approximately 1.4% annually. As a result of this small load growth based on the existing load forecast, the Baker Street Station 110 will support the forecasted load growth in the supply region through 2008. In the summer of 2008 for the contingency outage of two transformers, Baker Street Station 110 will be loaded at 84% of the load carrying capacity.

**Transmission:**

Loss of double circuit tower line 110-522 & 240-510 overloads 110-510/511 (Baker-Washington Tap 115 kV lines) (2004)

**Distribution:**

1. 24kV Dedham supply lines (Direct buried lines) have poor reliability 10 cable and joint failures over the past 6 years
2. 4kV Station 468 is overloaded under contingency conditions (2004)
3. 4kV circuit 468-06 is over its normal rating (2004)
4. 24 kV station Dedham Station 20 overloaded under contingency conditions (2006)
5. 4kV circuits 374-02 and 468-08 are over their normal rating (2008)

## Distribution Systems

### DSS Lines

- Baker Street Station 110 has five line groups; the Rockingham Avenue, Elliot Street, Corey Street, Baker Street and Dedham line groups.
- The Rockingham Avenue Line Group consists of DSS lines 468-2408 and 468-2412. The line group supplies NSTAR Rockingham Avenue Station 468. Upon the loss of a DSS line, the remaining DSS lines will not exceed the long-term emergency capacity (LTE), based on the 2004 forecast.
- The Elliot Street Line Group consists of DSS lines 292-2401X&Y and 292-2402X&Y. The line group supplies NSTAR Willow Street Station 516 and two normally open ties to Newton Station 292. Upon the loss of a DSS line, the remaining DSS lines will not exceed the long-term emergency capacity (LTE), based on the 2004 forecast.
- The Corey Street Line Group consists of DSS lines 110-2110 and 443-2211. The line group supplies NSTAR Corey Street Station 443 and one of the two transformers at customer Station 555 (U. S. Veterans Hospital). Upon the loss of either DSS line, the remaining DSS line will not exceed the long-term emergency capacity (LTE), based on the 2004 forecast.
- The Baker Street Line Group consists of DSS lines 110-2109 and 374-2215. The line group supplies NSTAR Baker Street Station 374 and one of the two transformers at customer Station 555 (U. S. Veterans Hospital). Upon the loss of either DSS line, the remaining DSS line will not exceed the long-term emergency capacity (LTE), based on the 2004 forecast.
- The Dedham Line Group consists of DSS lines 20-2405, 20-2406 and 20-2407. The line group supplies NSTAR East Street, Dedham Station 20 and TNV6100- West Roxbury High. Starting in 2004 upon the loss of any DSS line, the remaining DSS lines will exceed the long-term emergency capacity (LTE), based on the 2004 forecast. There is adequate RADSEC transfer capability off of the Dedham line group to adjacent stations to reduce loading below LTE during a contingency through 2008.

The table below provides the details on these line groups.

DSS Line	% of Normal 2004	LTE - % Load at Risk 2004	MVA at Risk 2004	LTE - % Load at Risk 2008	MVA at Risk 2008
468-2408	38%	0%	0	0%	0
468-2412	44%	0%	0	0%	0
292-2401XYZ	25%	0%	0	0%	0
292-2402XYZ	23%	0%	0	0%	0
110-2110	37%	0%	0	0%	0
443-2211	50%	0%	0	0%	0
110-2109	30%	0%	0	0%	0
374-2215	45%	0%	0	0%	0
20-2405	105%	0%	0	0%	0
20-2406	106%	0%	0	0%	0
20-2407	86%	0%	0	0%	0

#### *Baker Street Station 110 DSS Lines Loading*

Note: The Dedham line group 20-2405, 2406, & 2407 includes the transfer of load off the line group during a contingency.

### 24 kV Dedham Supply and Reliability

The three 24kV supply lines to Dedham Station 20 (20-2405, 20-2406, & 20-2407) are direct buried



lines that run between Baker Street Station 110 each approximately 3.25 miles in length. The lines have a history of reliability issues. Over the past 6 years there have been 10 cable and joint failures on the lines. The Dedham supply is heavily loaded, each line carries approximately 15MVA, in 2002 two of the lines were loaded to 99% of their normal rating while the third line was loaded to 80% of its normal rating. The heavy loading on the lines is a major contributor to the higher than typical failure rate on the lines. The combination of high failure rates, heavy loading and the direct buried construction of the lines create the potential for a two-line outage event. There is adequate transfer capability to off load the station in the event of a single line outage but rotating outages would be necessary for a two-line outage.

#### **14kV Distribution**

The 14kV distribution out Station 20 has adequate capacity. The 14kV distribution has 15 MVA of transfer capability to adjacent stations; this transfer can be utilized during a contingency on the 24kV supply to Dedham Station 20.

<b>14 kV Radial Line</b>	<b>% of Normal 2002</b>	<b>Projected % of Normal 2004</b>	<b>Projected % of Normal 2008</b>
20-H1	83%	85%	89%
20-H3	66%	68%	71%
20-H4	0%	0%	0%
(no load circuit)			
20-H5	70%	72%	75%
20-H6	65%	68%	70%
20-H7	39%	40%	42%

*Loading on Baker Street (Thru Station 20) Station 14kV radial lines.*

#### **4 kV Stations**

Baker Street supplies five 4kV stations. Rockingham Avenue Station 468 upon the loss of one of its two 10.5 MVA transformers, the remaining transformer will exceed its long-term emergency capacity. There is 1.1 MVA of load at risk in this event. . The table below summarizes the capacity of the 4 kV stations.

<b>4 kV Station</b>	<b>2002 Peak (MVA)</b>	<b>LTE Capacity (MVA)</b>	<b>2004 Projection (MVA)</b>	<b>2008 Projection (MVA)</b>
East Street #20	11.8	16.8	11.4	11.9
Baker Street	7.9	9.0	8.1	8.4
Sta #374				
Corey St #443	8.6	11.25	9.3	9.7
Rockingham Sta #468	11.6	10.5	11.7	12.2
Willow St #516	8.6	14.3	7.7	8.0

Loading on 4 kV station fed from Baker Street Station 110

**Proposed Integrated Plan**

The suggested actions listed in table below will address all of the capacity concerns in the region.

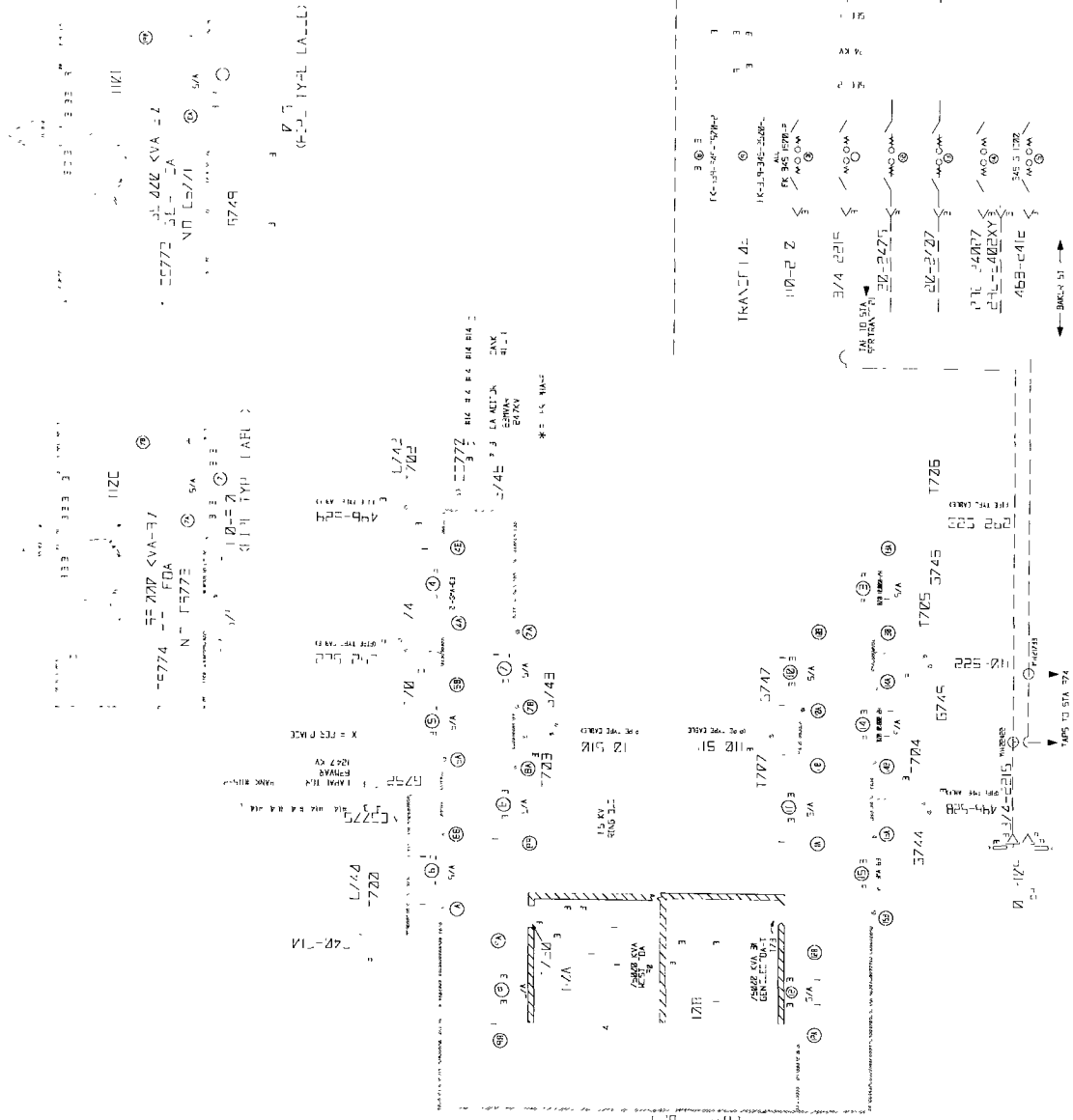
In the Baker Street Station 110 area, the immediate concern is the reliability and capacity issues related to the Dedham line group. To address the reliability and capacity concerns on the Dedham line group we have formulated a multiple phase plan to improve capacity to the Dedham area and eliminate our reliance on the poor performing direct buried 24kV supply lines. The first step will be use the expanded Dover Station 456 to relieve Dedham Station 20 by 5 –10 MVA. The next step would call for the installation of a new duct line from Baker Street Station 110 to Dedham Station 20 and replacement of the 24kV lines to Dedham. The new duct between West Roxbury and Dedham would include pipe for possible use for a transmission supply to Dedham Station 20. The new 24kV supply to Dedham would allow for the full utilization of the Station 20 24kV/14kV transformers and provide the necessary capacity in the Dedham area through 2008.

<b>Action</b>	<b>Year needed</b>	<b>Estimated Cost</b>
⇒ Relieve Dedham Station 20 – Extend circuit from Dover Station 456	2004	TBD
⇒ Install fans on two 8.4 MVA 14/4kV transformers at Station 468	2004	\$30K
⇒ Establish new circuit at Station 468 to relieve circuits 468-06 & 468-08	2004	\$100K
⇒ Installation of duct line between Station 110 and Station 20 and new 24kV cable to Dedham Station 20 or relieve station by load transfers to adjacent stations	2006 - 2007	TBD

*Recommended course of action for the Baker Street Region*

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▲ DO NOT USE CIRCUITRY THAT IS  
"USUALLY WHEN ENERGIZED"



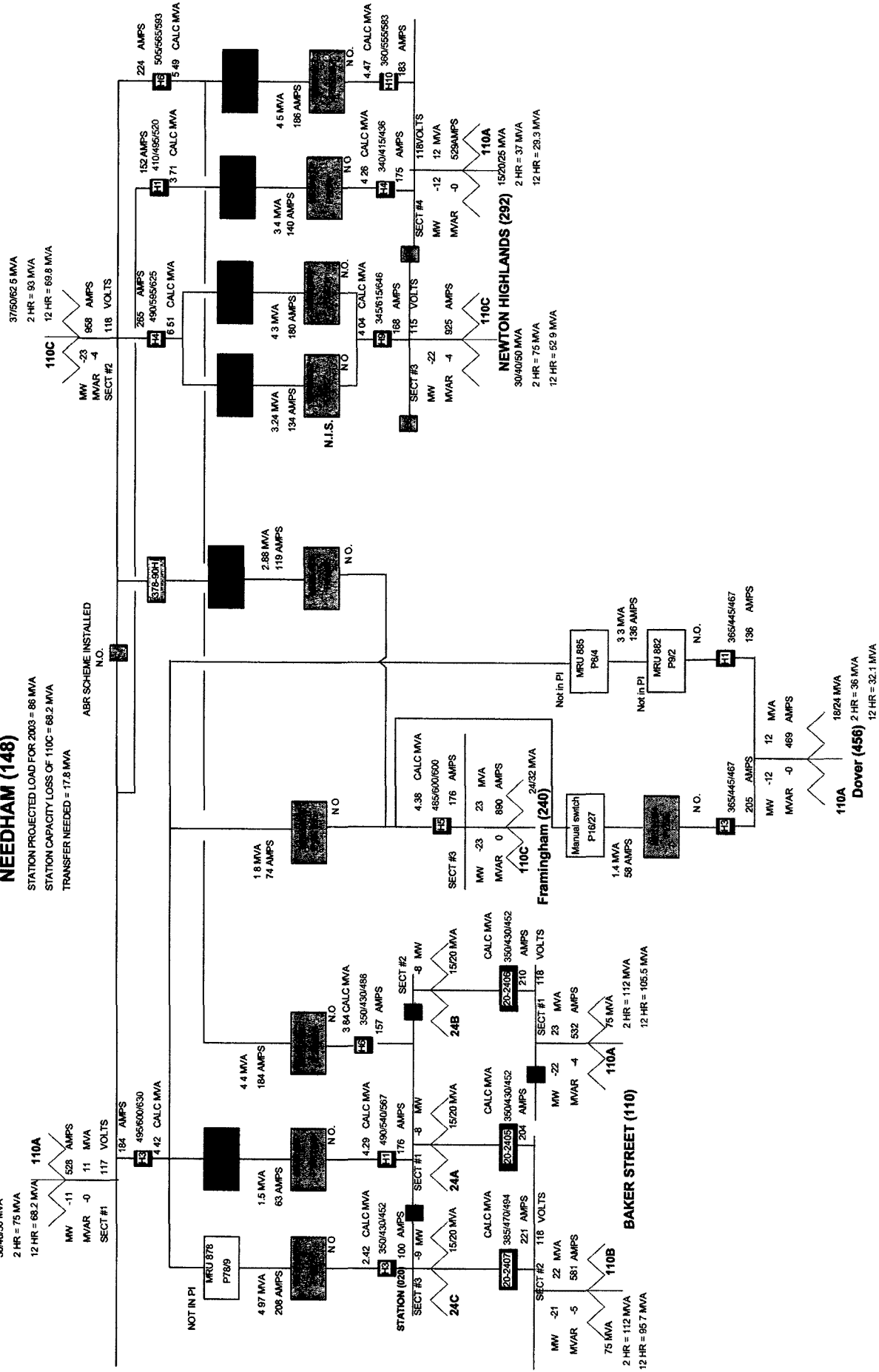
**BOSTON Edison COMPANY**  
**UTILITY ENGINEERING DEPARTMENT**  
**ELECTRICAL DESIGN DRAWING GROUP**

RAIN DY  
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**NEEDHAM (148)**

STATION PROJECTED LOAD FOR 2003 = 86 MVA  
STATION CAPACITY LOSS OF 110C = 68.2 MVA  
TRANSFER NEEDED = 17.8 MVA



## ***2004 T&D OPERATING STUDY MASS. AVENUE DISTRICT***

### **STATION #329 BRIGHTON**

Brighton Station 329 serves the following towns and communities: Allston, Brighton, Brookline, Jamaica Plain, Mission Hill and Roxbury. During the summer of 2002, the Brighton Station 329 peak load was 199 MVA. The station consists of two 115/14 kV transformers, one 115/24/14kV (unique to Brighton) and one 14/24kV transformer.

Transformer #110A: Waukesha 75/125/140 MVA 115 to 14.4/14.4 kV

Transformer #110B: Allis Chalmers 100 MVA 110 to 24.3 to 13.8/13.8 kV

Transformer #110C: Westinghouse 100/112 MVA 110 to 13.8/13.8 kV

Transformer #24A: Maloney 20 MVA 13.8 to 24 kV

Brighton Station 329 total capacity is 342 MVA. NSTAR employs summer emergency rating (cyclic capability) of 240 MVA. The Brighton Station 329 facilities and infrastructure have inherent reliability concerns. One of the primary concerns at Brighton Station is a thermal constraint in the station's distribution infrastructure. In August 2001, the Brighton supply suffered a significant outage event when 14 of the station's 32 feeders faulted over a 15-hour period. The cause of this event was attributed to thermal overload of the distribution cables exiting the station. Through thermal analysis of the Station 329 station getaways, the station's load carrying capability is limited to 217 MVA.

### **Overload Ratings:**

Transformer	Nameplate	12 hour LTE, 90F Ambient	12 hour LTE, 110F Ambient
110A	84/112/140 MVA	175 MVA	164 MVA
110B	100 MVA	142 MVA	132 MVA
110C	100/112 MVA	142 MVA	133 MVA

### **Station Capabilities:**

Total Station Capacity (N)	Station Firm Capacity (LTE)	RADSEC Transfer	Manual Transfer	Total LCC
342 MVA	240 MVA	15 MVA	2 MVA	217 MVA*

\* Load carrying capability limited due to distribution thermal constraint in the Brighton Station 329 getaway area in Harvard Avenue in Allston

### **Station Load Forecast:**

2004	2005	2006	2007	2008
218 MVA	232 MVA	248 MVA	258 MVA	265 MVA

## **Switching Actions:**

### **Loss of Transformer #110A:**

**Open:** Circuit Breakers #5 and #6

Disconnect Switch #T730

Main 110A 13.8kV Circuit Breaker

**Close:** Sections 1, 3 and 5 operate normally closed.

Sections 2, 4 and 6 operate normally open. Upon the loss of transformer

110A the ABR scheme closes section #4 and section #6 tie breakers. Sections

2, 4 and 6 are now tied together.

Circuit Breakers #5 and #6 to close 115kV ring

### **Loss of Transformer #110B:**

**Open:** Circuit Breakers #8 and #9

Disconnect Switch #T731

Main 110B 13.8kV Circuit Breaker

**Close:** Sections 1, 3 and 5 operate normally closed.

Sections 2, 4 and 6 operate normally open. Upon the loss of transformer

110B the ABR scheme closes section #4 and section #6 tie breakers. Sections

2, 4 and 6 are now tied together.

Circuit Breakers #8 and #9 to close 115kV ring

### **Loss of Transformer #110C:**

**Open:** Circuit Breakers #2 and #3

Circuit Switcher #CS771

Main 110c 13.8kV Circuit Breaker

**Close:** Sections 1, 3 and 5 operate normally closed.

Sections 2, 4 and 6 operate normally open. Upon the loss of transformer 110C

the ABR scheme closes the section #4 and section #6 tie breakers. Sections

2, 4 and 6 are now tied together.

Circuit Breakers #2 and #3 to close 115kV ring

## **Transfer Switching:**

For any transformer outage, remaining in-service transformers carry full station load of 218.0 MVA.

Station 329 Brighton has 17 MVA of RADSEC and manual transfer capability with Newton Station 292, Watertown Station 467, and Hyde Park Station 496. Use of the distribution transfer is not required for a transformer outage at Brighton.

## **Summary of Concerns: Brighton Region**

Significant development is expected in the Brighton Supply area between 2004-2008, the region is projected to experience heavy load growth, approximately 4.9% annually. The Brighton supply the area has numerous emerging distribution capacity issues beginning in 2004. The strain on the existing distribution infrastructure is driven by the continued development in the Longwood Medical Area, and Fenway-Kenmore Area (Boston University). As a result of this significant load growth, the Brighton Station 329 is forecasted to exceed its load carrying capability beginning in 2004, with 1

MW of load at risk. By the summer of 2008 for a single-contingency outage of transformer 110A, Brighton Station 329 could attain a loading of 122% of its load carrying capability and the load at risk would be 48 MVA.

**Transmission:**

1. Loss of one of the Mystic - Brighton 115kV lines (329-510/511) will exceed the LTE limit of the remaining line starting in 2008.
2. Loss of one of the Brighton – Cambridge 115kV lines (329-530/531) will exceed the LTE limit of the remaining line starting in 2008.

**Distribution:**

1. Inadequate load carry capability (2004), distribution limitation
2. No Spare for transformer 110B a 115/24/14 kV transformer
3. Distribution thermal issues on Harvard Avenue, Allston
4. Harvard Court line group overloaded under contingency conditions (2004)
5. Harvard Institute of Medicine line group overloaded under contingency (2004)
6. Back Bay line group overloaded under contingency (2004)
7. Radial 14kV circuit 329-H7 is overload under normal conditions (2004)
8. Reliability issues with the 24kV supply out of Brighton, concern with 24kV transformers at Station 329 and the supply lines to Jackson Square Station 396
9. Allston line group overloaded under contingency (2008)
10. 4 kV lines 36-09, 36-13, and 506-10 overloaded under normal conditions (2008)
11. 14kV lines 329-H1, 329-H4, 329-H6 overloaded under normal conditions (2008)

**Distribution Systems**

***DSS Lines***

Four line groups (Harvard Court, Harvard Institute of Medicine, Back Bay and Allston) were evaluated for N-1 conditions for projected 2004 and 2008 loading.

- The Harvard Court line group is composed of DSS lines 506-138H, 506-140H and 506-173H. This line group serves the Brookline Village and Coolidge Corner sections of the Town of Brookline. Upon the loss on one of the three lines, the others will exceed their long-term emergency capacity (LTE).
- The Harvard Institute of Medicine line group is composed of DSS lines 329-1N172H, 426-169H, 493-136H and 493-175H. This line group serves customers in the Longwood Medical Area. Upon the loss on one of the 493 lines, the others will exceed their long-term emergency capacity (LTE).
- The Back Bay line group is composed of DSS lines 233-90H, 419-92, 522-160H and 586-90. This line group serves Boston University, the Christian Science Center, Fenway Park and Harvard Community Health. Upon the loss on one of the three lines, the others will exceed their long-term emergency capacity (LTE).
- The Allston line group is composed of DSS lines 36-104, 36-157XY, 36-51, 36-82, 508-91, 543-158 and 595-90. This line group serves customers in Allston including Barry Controls, and Genzyme. In 2008, upon the loss on of lines 36-104, 36-157XY, 36-51 or 508-91, the others will exceed their long-term emergency capacity (LTE). The table below provides details on the DSS lines for the Brighton Station area.

<b>DSS Line</b>	<b>% of Normal 2004</b>	<b>LTE - % Load at Risk 2004</b>	<b>MVA at Risk 2004</b>	<b>LTE - % Load at Risk 2008</b>	<b>MVA at Risk 2008</b>
506-138H	117%	0%	0	12%	1.2
506-140H	79%	6%	0.6	26%	2.9
506-173H	101%	9%	0.8	30%	3.2
329-1N172H	104%	0%	0	33%	2.7
426-169H	106%	0%	0	8%	1.0
493-136H	105%	36%	3.1	36%	3.1
493-175H	97%	56%	3.0	56%	3.0
233-90H	85%	62%	4.4	33%	2.7
419-92	113%	34%	3.2	8%	1.0
522-160H	86%	36%	2.6	36%	3.1
586-90	35%	0%	0	56%	3.0
36-104	85%	0%	0	5%	0.4
36-157XY	41%	0%	0	3%	0.1
36-51	44%	0%	0	16%	1.0
36-82	88%	0%	0	0%	0
508-91	72%	0%	0	26%	2.0
543-158	68%	0%	0	0%	0
595-90	81%	0%	0	0%	0
404-176	50%	0%	0	0%	0
421-132	46%	0%	0	0%	0
571-174	56%	0%	0	0%	0
329-1N40H	75%	0%	0	0%	0
329-1N51H	56%	0%	0	0%	0
548-92H	89%	0%	0	0%	0
329-2211	31%	0%	0	0%	0
329-2215	53%	0%	0	0%	0

*Loading on Brighton DSS lines.*

#### **14kV Distribution**

One of the seven 14kV radial lines fed from Brighton Station 329 is projected to exceed its normal rating in 2004; 329-H7. By 2008 four of the seven lines will exceed their normal, 329-H1, 329-H4, 329-H6 and 329-H7.

<b>14 kV Radial Line</b>	<b>% of Normal 2002</b>	<b>Projected % of Normal 2004</b>	<b>Projected % of Normal 2008</b>
329-H1	87%*	95%	115%
329-H2	71%	78%	95%
329-H3	52%	84%	96%
329-H4	79%	86%	105%
329-H5	74%	81%	98%
329-H6	63%	86%	101%
329-H7	72%	103%	120%

*Loading on 14 kV radial lines.*



**4kV Substations**

Brighton Station 329 feeds three 4 kV stations and the Brookline Network made up of five primary network units (PNU): Allston Station 36 (Commonwealth Avenue), Jackson Square Station 396 (Amory Street, Jamaica Plain), Harvard Court Station 506 (Harvard Court, Brookline) and the Brookline Primary Network. The loads at all the 4kV stations supplied by Brighton Station 329 are projected to decrease because of on-going 4kV conversions. The 4kV conversions are addressing reliability and community concerns in the areas served by these stations. The conversions of the Jackson Square Station circuits will correct the heavy loading on the station transformers. The table below summarizes the capacity of these 4 kV stations.

<b>4 kV Station</b>	<b>2002 Peak (MVA)</b>	<b>LTE Capacity (MVA)</b>	<b>2004 Projection (MVA)</b>	<b>2008 Projection (MVA)</b>
Station 36	26.0	35.9	23.4	24.3
Station 396	12.9	11	8.7	9.0
Station 506	15.5	22.5	12.1	12.6
Brookline Network	14.3	20.5	11.3	11.7

*Loading on 4 kV stations fed from Brighton Station 329*

**Proposed Integrated Plan**

The suggested actions listed in the table below will address all of the capacity concerns in the region.

The proposed Colburn Street Substation will have a significant impact on the substation and distribution capacity in the Brighton Station 329 area as well as the four other abutting areas (Andrew Square (South Boston) Station 106, Dewar Street (Dorchester) Station 483, Hyde Park Station 496 and Scotia Street (Back Bay) Station 492). The substation and associated distribution infrastructure are the foundation for much of Brighton area capacity plans for the next 5 years. The new station will be developed to provide expanded distribution and substation capacity to supply the loads within City of Boston neighborhoods of Jamaica Plain, Roxbury, Mission Hill, Longwood Medical Area and Kenmore-Fenway and the Brookline Village section of Town of Brookline. The proposed site is located at the epicenter of the load in the area. Because of the close proximity to the load, circuit lengths will be reduced to an average length of 6,300 circuit feet from the existing circuit length of 14,500 circuit feet. The firm capacity of the new station will be 150 MVA, which supports the relief of five bulk supply substations and the projected load growth within the Colburn Street service area. The station will be designed to accommodate a 4<sup>th</sup> transformer and a firm capacity of 225 MVA. This alternative is part of an integrated long-term solution for the Boston Radial supply area, which will provide the capacity additions needed to meet the new load requirements as well as insure the reliability of service of this area.

<b>Action</b>	<b>Year needed</b>	<b>Estimated Cost</b>
⇒ New Colburn Street Substation	2004 - 05	\$27.8MM
⇒ Reconfigure the Back Bay line group	2005	TBD
⇒ Relieve circuit 329-H7 using 506-138H feeder position	2005	TBD
⇒ Establish new circuit to relieve 329-H1 & H2	2006	TBD
⇒ Reconductor or reconfigure circuit 329-H4	2007	TBD
⇒ Establish new circuit to relieve 329-H6	2007	TBD

**Recommended course of action for the Brighton Region**





## ***2004 T&D OPERATING STUDY MASS. AVENUE DISTRICT***

### **STATION #385D K STREET (Distribution)**

The L Street Station #4 and the new K Street Station #385D serve the South Boston section of Boston. The new K Street substation #385D and associated distribution infrastructure will be developed to provide expanded substation capacity to supply the increased loads within the South Boston Waterfront region. The initial firm capacity of the new station will be 75 MVA (Phase 1 In-Service date November, 2003), which supports the start of retiring of L Street Station 4 and the initial load growth within the South Boston Waterfront. The new K Street Station #385D was designed to accommodate a firm capacity of 225 MVA. Phase 2 of the K Street Station #385 D, which has an In-service date of June 1, 2004, will install a third and fourth transformer, increasing the firm capacity to 225 MVA. The new K Street Station #385D project is part of an integrated long-term solution, which will provide the necessary capacity additions needed to meet the new load requirements as well as insure the reliability of service of this area.

K Street Station #385D consists of the following transformers:

Transformer #110A: VA Tech Ferranti-Packard 37.5 / 50 / 65.5 MVA 117 kV to 15.12 kV

Transformer #110B: VA Tech Ferranti-Packard 37.5 / 50 / 65.5 MVA 117 kV to 15.12 kV

Transformer #110C: VA Tech Ferranti-Packard 37.5 / 50 / 62.5 MVA 117 kV to 15.12 kV

Transformer #110D: VA Tech Ferranti-Packard 37.5 / 50 / 62.5 MVA 117 kV to 15.12 kV

K Street Station #385D total capacity is 250 MVA. NSTAR employs summer emergency rating (cyclic capability) of 75 MVA for each of these transformer banks. The Kingston-K Street 115kV lines 385-510 and 385-511 supply High Street Station #385. The outage of one of these transmission lines would result in the loss of one of K Street Sta #385D transformers. The station has a firm capacity of 225 MVA. As a secondary network station there is no transfer switching capability to adjacent network stations. K Street's load carrying capability (i.e. firm capacity + transfer switching) is 225 MVA.

### **Overload Ratings:**

Transformer	Nameplate	12 hour LTE, 90F Ambient	12 hour LTE, 110F Ambient
110A	37.5/50/65.5 MVA	87.6 MVA	80.1 MVA
110B	37.5/50/65.5 MVA	87.6 MVA	80.1 MVA
110C	37.5/50/62.5 MVA	87.6 MVA	80.1 MVA
110D	37.5/50/62.5 MVA	87.6 MVA	80.1 MVA

### **Station Capabilities:**

Total Station Capacity (N)	Station Firm Capacity (LTE)	RADSEC Transfer	Manual Transfer	Total LCC
256 MVA	225 MVA*	0 MVA	0 MVA	225 MVA

\* Based upon loss of 110A, or 110B, or 110C or 110D.

**2004-2008 Projected load:**

2004	2005	2006	2007	2008
180 MVA	194 MVA	204 MVA	208 MVA	212 MVA

**Switching Actions:**

**Loss of Transformer #110A**

- Open:** OCB's 7 & 8 @ K Street Station #385T  
 OCB (110A) @ K Street #385D  
 Main 110A 13.8kV Secondary Circuit Breaker  
 ABR Scheme Opens 13.8kV Bus Tie Breakers between sections 1C and 1D, and sections 1D and 3B
- Close:** ABR Scheme Closes 13.8kV Bus Tie Breakers between sections 2B and 2C, and sections 3A and 3B

**Loss of Transformer #110B**

- Open:** OCB's 12 & 15 @ K Street Station #385T  
 OCB (110B) @ K Street St#385D  
 Main 110B 13.8kV Secondary Circuit Breaker  
 ABR Scheme Opens 13.8kV Bus Tie Breakers between sections 2C and 1D, and sections 1D and 3B
- Close:** ABR Scheme Closes 13.8kV Bus Tie Breakers between sections 2B and 2C, and sections 3A and 3B

**Loss of Transformer #110C**

- Open:** OCB's 5 & 6 @ K Street Station #385T  
 OCB (110C) @ K Street St#385D  
 Main 110C 13.8kV Secondary Circuit Breaker  
 ABR Scheme Opens 13.8kV Bus Tie Breakers between sections 2C and 1D, sections 1D and 1C, and sections 1D and 3B
- Close:** ABR Scheme Closes 13.8kV Bus Tie Breakers between sections 2B and 2C, and sections 3A and 3B

**Loss of Transformer #110D**

- Open:** OCB's 19 & 20 @ K Street Station #385T  
 OCB (110D) @ K Street St#385D  
 Main 110D 13.8kV Secondary Circuit Breaker  
 ABR Scheme Opens 13.8kV Bus Tie Breakers between sections 2C and 1D, and sections 1D and 1C
- Close:** ABR Scheme Closes 13.8kV Bus Tie Breakers between sections 2B and 2C, and

sections 3A and 3B.

### **Summary of Concerns: K Street Supply Region**

1. Increase capacity requirements - redevelopment of the South Boston Waterfront
2. 14kV circuit 4-H10 overloaded under normal conditions (2004)
3. 14kV circuit 4-H5 overloaded under normal conditions (2007)
4. 14kV circuit 4-H7 n-1 constraint (2007)
5. South Boston Postal and Park Plaza line groups overloaded under contingency (2007)

The South Boston region continues to experience load growth. Many of the properties are being redeveloped for new economic uses. Much of the impetus for the development comes from the region's proximity to the Boston financial district, the downtown waterfront and new transportation infrastructure. The developers in the South Boston Waterfront region are essentially building a small city. The Waterfront region is evolving through various developmental stages. The district will be a highly mixed area including office buildings, hotels, residential condominiums, retail shops, restaurants and entertainment that will maintain a lively set of activities both day and evening. The Boston Convention and Exposition Center is the first in a series of major customer development projects that will significantly increase the load within the South Boston region. The projected probable new load will likely be 35-45 MVA by the middle of this decade.

Based on load projections, by in the summer of 2008 for the contingency outage of a transformer, K Street Station #385D will be loaded at 92% of the firm capacity.

### **Distribution System**

#### **DSS Lines**

Four line groups (South Postal, Park Plaza, Gillette, and Congress) were evaluated for N-1 conditions for projected 2004 and 2008 loading.

The South Postal group, which supplies the South Boston Postal Annex, was found to have issues during the loss of line 474-135 in 2008. During a line outage at least a 7% of the load is at risk because the load transfer puts the receiving line over its LTE rating.

The Park Plaza line group, which supplies the Park Plaza Hotel, is being relieved in 2003. The line group was found to have issues during the loss of line 141-198H in 2008 and beyond.

The Gillette line group, which supplies Gillette Corp., is being relieved with the addition of a new supply. The Gillette line is projected to have adequate capacity to meet the load requirements through 2008.

The Congress line group, which supplies the Congress Street section of South Boston via NSTAR 4kV Station 430, was found to have adequate capacity to supply the load through 2008.

<b>DSS Line</b>	<b>% of Normal 2004</b>	<b>LTE - % Load at Risk 2004</b>	<b>MVA at Risk 2004</b>	<b>LTE - % Load at Risk 2008</b>	<b>MVA at Risk 2008</b>
474-136H	91%	0%	0	0%	0

474-135	54%	0%	0	7%	0.2
403-137H	49%	0%	0	0%	0
347-92	45%	0%	0	0%	0
141-70	17%	0%	0	0%	0
141-198H	72%	0%	0	3%	0.2
515-193	71%	0%	0	0%	0
515-193	37%	0%	0	0%	0
430-157	58%	0%	0	0%	0
422-165	72%	0%	0	0%	0
430-157	59%	0%	0	0%	0
430-156	49%	0%	0	0%	0

### 14kV Distribution

One of the twelve 14kV radial lines fed from K Street Station # 385D is projected to exceed its normal rating in 2004; 4-H10. In 2008, 4-H5 and 4-H10 are projected to exceed their normal rating.

14 kV Radial Line	% of Normal 2002	Projected % of Normal 2004	Projected % of Normal 2008
385-H1	3%	14%	16%
385-H2	28%	28%	30%
385-H3	56%	58%	60%
385-H4	9%	9%	9%
385-H5	97%	99%	101%
385-H7	88%	90%	92%
385-H8	45%	47%	48%
385-H9	36%	37%	38%
385-H10	100%	102%	104%
385-H11	64%	65%	67%
385-H14	105%	69%	71%

### 4kV Substation

L Street Station 4 feeds three 4 kV stations: Summer Street Station 293, Congress Station 430, and Dorchester Avenue Station 139. The loads all of the 4kV stations supplied by L Street Station 4 are projected to operate within their LTE ratings through 2008.

4 kV Station	2002 Peak (MVA)	LTE Capacity (MVA)	2004 Projection (MVA)	2008 Projection (MVA)
Station 293	7.9	18	8.3	8.6
Station 430	7.8	13.4	8.0	8.3
Station 139	13.3	18.8	13.6	14.0

### Proposed Integrated Plan

The new K Street 115/14 kV substation is part of an integrated long-term solution, which will provide the necessary capacity additions needed to meet the South Boston region's new load requirements as well as ensure the reliability of service of this area. The development of the new K Street 115/14 kV substation

will support the retirement of L Street Station #4 by transferring most of the load presently supplied from L Street to K Street, thereby addressing a potentially significant reliability concern. The new K Street 115/14 kV station has capacity that would provide a measure of load relief of Andrew Square Station #106, approximately 25 MVA.

<b>Action</b>	<b>Year needed</b>	<b>Cost</b>
Reconductor 385-H10 (4-H10)	2004	\$250K
Reconductor 385-H5 (4-H5)	2005	\$250K
Reconductor 385-H7 (4-H7 or relieve via load transfers to adjacent distribution circuits	2006	TBD
Installation of new line to relieve the Park Plaza line group or transfer load from line group to adjacent lines	2007	TBD
Installation of new line to relieve the South Postal line group or transfer load from line group to adjacent lines	2008	TBD





## ***2004 T&D OPERATING STUDY MASS. AVENUE DISTRICT***

### **STATION #483 DEWAR STREET**

Dewar Street Station 483 serves the following towns and communities: Dorchester, and portions of Mission Hill, Roxbury and the Town of Milton. During the summer of 2002, the Dewar Street Station 483 peak load was 135 MVA. The station consists of two 115/14 kV transformers.

Transformer #110A: McGraw-Edison 84 / 112 / 140 MVA 115 to 14.4/14.4 kV

Transformer #110B: General Electric 84 / 112 / 140 MVA 115 to 14.4/14.4 kV

Dewar Street Station 483 total capacity is 265 MVA. NSTAR employs summer emergency rating (cyclic capability) of 151 MVA. There is no transfer switching to adjacent substations. The station has a firm capacity of 151 MVA. Due to a transmission constraint on 483-524/525 Dewar Street's load carrying capability is limited to 135 MVA.

### **Overload Ratings:**

Transformer	Nameplate	12 hour LTE, 90F Ambient	12 hour LTE, 110F Ambient
110A	84/112/140 MVA	175 MVA	164 MVA
110B	84/112/140 MVA	182 MVA	170 MVA

### **Station Capabilities:**

Total Station Capacity (N)	Station Firm Capacity (LTE)	RADSEC Transfer	Manual Transfer	Total LCC
265 MVA	151 MVA*	0 MVA	2 MVA	135 MVA**

\* Based upon 110A/483-524 or 110B/483-525.

\*\*The load carrying capability (LCC) is limited due to an n-1 constraint on transmission lines 483-524/525.

### **Station Load Forecast:**

2004	2005	2006	2007	2008
138 MVA	140 MVA	141 MVA	143 MVA	145 MVA

### **Switching Actions:**

**Loss of Transformer #110A also isolates the 483-524 Line and 110D @ Andrew Sq**

**Open:** OCB's 13 & 14 @ K Street

OCB 3 and CS774 @ Andrew Sq (110D transformer)

Circuit Switcher CS771

Both Main 110A 13.8kV Circuit Breakers

**Close:** ABR scheme closes bus ties

Manually close OCB's 13 & 14 @ K Street

Manually close OCB 3, CS774 and restore 110D @ Andrew Sq

Loss of Transformer #110B also isolates the 483-525 Line and 110C @ Andrew Sq

**Open:** OCB's 4 & 7 @ K Street

OCB 1 and CS772 @ Andrew Sq (110C transformer)

Circuit Switcher CS770

Both Main 110B 13.8kV Circuit Breakers

**Close:** ABR scheme closes bus ties

Manually close OCB's 4 & 7 @ K Street

Manually close OCB 1, CS772 and restore 110C @ Andrew Sq

### **Summary of Concerns: Dewar Street Station 483 Region**

No major development is expected in the Dewar Supply area between 2004-2008, the region is projected to experience meager load growth load growth, approximately 1.2% annually. For any transformer outage, the remaining in-service transformer carries full station load of 138.0 MVA. For the loss of either transmission line 483-524 or 525 Dewar Street's load carrying capability of 135 MVA is exceed by less than 1%, with approximately 3 MW of load at risk of load shedding. There is no transfer capability with any other station from Dewar Street Station 483.

### **Transmission:**

1. Loss of one of the K Street – Andrew Square – Dewar Lines (483-524/525) will exceed the LTE limit of the remaining line starting in 2004.

### **Distribution:**

1. Dewar Street Station inadequate load carry capability (2004), n-1 transmission limitation
2. Dewar Street Station - short circuit current /overloaded transformer secondaries (2004)
3. Hallet line group overloaded under contingency (2004)
4. 14kV distribution lines 483-H1, 483-H2, and 483-H4 projected to be overloaded under normal conditions (2004)
5. 4kV distribution 52-11 projected to be overloaded under normal conditions (2004)
6. 4kV distribution 52-06 projected to be overloaded under normal conditions (2008)

### **Distribution Systems**

#### **DSS Lines**

The Hallet Street and Central Avenue line groups were evaluated for N-1 conditions for projected 2004 and 2008 loading.

- The Hallet Street line group, which supplies the MBTA Station at Tenean Street and the Saint Mark's neighborhood of Dorchester, was found to have issues during the loss of line 466-1482H in 2004 and beyond. During a line outage at least a 33% of the load is at risk because the load transfer puts the receiving line over its LTE rating.
- The Central Avenue line group, which supplies the Lower Mills section of Dorchester via NSTAR 4kV Station 43, was found to have adequate capacity to handle the loss of any line in the line group through 2008.

<b>DSS Line</b>	<b>% of Normal 2004</b>	<b>LTE - % Load at Risk 2004</b>	<b>MV A at Risk 2004</b>	<b>LTE - % Load at Risk 2008</b>	<b>MVA at Risk 2008</b>
466-1482H	113%	33%	3.2	39%	3.9
466-1481H	86%	0%	0	1%	.1
483-1493	100%	0%	0	0%	0
43-1491H	88%	0%	0	0%	0
43-1490H	74%	0%	0	0%	0
43-1489H	77%	0%	0	0%	0

*Loading on Dewar Street DSS lines.*

### **14kV Distribution**

One of the six 14kV radial lines fed from Dewar Street Station 483 is projected to exceed its normal rating in 2004; 483-H4. Circuits 483-H1 and H2 exceeded their normal rating in 2002 and are being relieved as part of a 2003 Dorchester distribution capacity improvement project. The remaining Dorchester distribution circuits have adequate capacity.

<b>14 kV Radial Line</b>	<b>% of Normal 2002</b>	<b>Projected % of Normal 2004</b>	<b>Projected % of Normal 2008</b>
483-H1	104%	85%	91%
483-H2	102%	73%	78%
483-H3	56%	58%	60%
483-H4	100%	102%	107%
483-H5	80%	81%	86%
483-H6	61%	63%	66%

*Loading on Dewar Street Station 14kV radial lines.*

### **4kV Substation**

Dewar Street Station 483 feeds five 4 kV stations: Cottrell Street Station 321, Central Avenue Station 43, Dewar Street Station 483, Roxbury Crossing Station 52 and Hoyt Street Station 67. The loads at four of five of the 4kV stations supplied by Dewar Street Station 483 are projected to decrease because of on-going 4kV conversions. The 4kV conversions are addressing reliability and community concerns in the areas served by these stations. The conversion of portions of circuit 321-05 out of the Cottrell Street Station 321 will reduce the heavy loading on the station transformers. The table below summarizes the capacity of these 4 kV stations.

<b>4 kV Station</b>	<b>2002 Peak (MVA)</b>	<b>LTE Capacity (MVA)</b>	<b>2004 Projection (MVA)</b>	<b>2008 Projection (MVA)</b>
Station 321	7.0	7.5	7.2	6.4
Station 43	12.7	15.0	11.9	12.4
Station 483	9.6	15.0	8.4	8.7
Station 52	12.8	16.4	11.7	11.2
Station 67	5.9	7.5	6.0	6.3

*Loading on 4 kV stations fed from Dewar Street Station 483*

### **Proposed Integrated Plan**

The suggested actions listed in the table below will address all of the capacity concerns in the region. The proposed Colburn Street Substation will have a significant impact on the substation and distribution capacity in the Dewar Station 483 area. The substation and associated distribution infrastructure will provide the foundation for all of the Dewar Street area capacity needs for the next 5 years. The new station will allow for the release of Dewar Street feeders for use in the Dorchester area. The new Colburn Street station will supply Longwood Medical area and Roxbury Crossing loads currently served by Dewar Street. The station relief provided by the Colburn Street substation will provide the Dewar Station with adequate substation capacity to meet the capacity requirements of the Dorchester area through 2008. The Dewar Street station relief will also alleviate the n-1 transmission over load condition on the K Street – Andrew Square – Dewar Lines (483-524/525). The Colburn Street project will address capacity issues on the Hallet Street line group, and circuit 483-H4. The new distribution circuits will also create transfer capabilities between Dewar Street Station 483 and the new Colburn Street Station 350, allowing for increased substation transformer utilization.

Action	Year needed	Estimated Cost
⇒ New Colburn Street Substation <b>see Brighton Area</b>	2004 – 05	
⇒ Installation of cap banks for power factor correction and voltage support	2004	\$100K
⇒ Installation of line reactors on 1 distribution circuit on busses 1 & 2 and cutover of lines to allow for open bus tie on busses 3 & 4	2004	\$400K
⇒ Install new distribution circuit to relieve 483-H1 or transfer load to adjacent circuits within the Dewar Supply region	2006	TBD

*Recommended course of action for the Dewar Street Region*



## ***2004 T&D OPERATING STUDY MASS. AVENUE DISTRICT***

### **STATION #492 SCOTIA STREET**

Scotia Street Station #492 supplies the Back Bay/Prudential/Kenmore Square (Sta #49) regions of the City of Boston. In the summer of 2002 the Scotia Street Station #492 load was 142 MVA.

Scotia Street Station #492 consists of the following transformers:

Transformer #110A: McGraw-Edison 84 / 112 / 140 MVA 115 to 14.4/14.4 kV

Transformer #110B: McGraw-Edison 84 / 112 / 140 MVA 115 to 14.4/14.4 kV

Scotia Street Station #492 total capacity is 280 MVA. NSTAR employs summer emergency rating (cyclic capability) of 151 MVA for each of these transformer banks. The station has a firm capacity of 151 MVA. As a secondary network station there is no transfer switching capability to adjacent network stations. Scotia Street's load carrying capability (i.e. firm capacity + transfer switching) is 151 MVA.

### **Overload Ratings:**

Transformer	Nameplate	12 hour LTE, 90F Ambient	12 hour LTE, 110F Ambient
110A	84/112/140 MVA	175 MVA	164 MVA
110B	84/112/140 MVA	173 MVA	162 MVA

### **Station Capabilities:**

Total Station Capacity (N)	Station Firm Capacity (LTE)	RADSEC Transfer	Manual Transfer	Total LCC
250 MVA	151 MVA*	0 MVA	0 MVA	151 MVA

\* Based upon loss of 110A/329-512 Line or 110B/329-513 Line.

### **2004-2008 Projected load:**

2004	2005	2006	2007	2008
149 MVA	152 MVA	153 MVA	156 MVA	159 MVA

### **Switching Actions:**

Loss of Transformer #110A also isolates the 329-512 line and 110A transformer @ Carver St

**Open:** OCB's 1 & 2 @ Kingston St

OCB's 3 & 6 @ Brighton

Circuit Switcher CS771 and the 110A transformer @ Carver St

Circuit Switcher CS771

Both Main 110A 13.8kV Circuit Breakers

**Close:** Nothing, bus tie operated normally closed

Manually close OCB's 1 & 2 @ Kingston St

Manually close OCB's 3 & 6 @ Brighton

Manually close CS771 and restore 110A @ Carver St

Loss of Transformer #110B also isolates the 329-513 line and 110B transformer @ Carver St

- Open:** OCB's 4 & 5 @ Kingston St  
OCB's 9 & 12 @ Brighton  
Circuit Switcher CS770 and the 110B transformer @ Carver St  
Circuit Switcher CS770  
Both Main 110B 13.8kV Circuit Breakers
- Close:** Nothing, bus tie operated normally closed  
Manually close OCB's 4 & 5 @ Kingston St  
Manually close OCB's 9 & 12 @ Brighton  
Manually close CS770 and restore 110B @ Carver St

### **Summary of Concerns:**

1. Network feeders overloaded under contingency conditions (2004-2008)
2. Scotia Street Station #492 is overloaded under contingency conditions (2005)
3. 4 kV distribution circuits 49-01, 49-07 and 49-08 is overloaded under normal conditions (2004-2008)

The Back Bay/Prudential region continues to evolve through various development stages. The region is a highly mixed area including office buildings, hotels, residential apartments and condominiums, retail shop, restaurants and entertainment that maintain a lively set of activities both day and evening.

Much of the impetus for the continued development comes from the region's being a vibrant and economically active portion of the city of Boston. The anticipated development will increase the load within this region. The new load will strain the capability of Scotia Street #492's substation and distribution infrastructure to support the customer load requirements.

Based on load projections, by in the summer of 2005 for a single-contingency outage of either transformer 110A or 110B, Scotia Street Station #492 will exceed the firm capacity. The new load will strain the capability of Scotia Street #492's substation and distribution infrastructure to support the customer load requirements. Since Scotia Street Station #492 is a secondary network station the load at risk is the entire station 151 MW (13,000 customers).

By the summer of 2008 for a single-contingency outage of either transformer 110A or 110B, Scotia Station #492 could attain a loading of 105% of Firm Capacity and the load at risk would be 20 MVA.

The development of the new Colburn Street 115/14kV substation will provide capacity to relieve five heavily loaded bulk supply stations: Andrew Square Station 106, Brighton Station 329, Dewar Street Station 483, Scotia Street Station 492 and Hyde Park Station 496. Prior to June 1, 2005 the Colburn Street Station project will several new lines which will support the relief of Scotia Street Station by cutover Station 49 in Kenmore Square and Northeastern University Station 573 - 23 MVA of relief.

### **Distribution Systems**

#### **DSS Lines**

Scotia Station #492 has two line groups the Kenmore Square and Northeastern Dormitories line groups.

The **Kenmore Square Line Group** consists of DSS lines 49-209, 49-210 and 49-211. The line



group supplies NSTAR Beacon Street/Kenmore Square Station #49 and Customer Stations #481 and #573. Upon the loss of a DSS line, the remaining DSS lines will not exceed the long-term emergency capacity (LTE), based on 2004-2008 peak load projections.

The **Northeastern Dormitories Line Group** consists of DSS lines 49-211 and 573-212. The line group supplies customer station # 573. Upon the loss of either DSS line, the remaining DSS line will not exceed the long-term emergency capacity (LTE), based on 2004-2008 peak load projections.

<b>DSS Line</b>	<b>% of Normal 2004</b>	<b>LTE - % Load at Risk 2004</b>	<b>MVA at Risk 2004</b>	<b>LTE - % Load at Risk 2008</b>	<b>MVA at Risk 2008</b>
49-209	58%	0%	0	0%	0
49-210	79%	0%	0	0%	0
49-211	99%	0%	0	0%	0
573-212	42%	0%	0	0%	0

#### 14 kV Network Feeders

There are twenty network feeders supplied from Scotia Street Station #492. By the summer 2004 four network feeders 492-1N11N, -1N22N, 1N45N and 1N46S will be heavily loaded exceeding 90% of normal rating. The following table summarized the performance of the network feeders.

<b>14kV Network Lines</b>	<b>% of Normal 2002</b>	<b>Projected % of Normal 2004</b>	<b>Projected% of Normal 2008</b>
492-1N11N	88%	93%	98%
492-1N12N	84%	89%	94%
492-1N13S	77%	82%	86%
492-1N14S	60%	64%	67%
492-1N15S	78%	83%	87%
492-1N21S	36%	38%	40%
492-1N22N	88%	94%	99%
492-1N23S	72%	76%	80%
492-1N24S	66%	71%	74%
492-1N25N	84%	89%	94%
492-1N31N	72%	76%	80%
492-1N32N	83%	88%	92%
492-1N33S	84%	89%	94%
492-1N34S	80%	85%	90%
492-1N35S	20%	21%	22%
492-1N42S	75%	80%	84%
492-1N43N	55%	59%	62%
492-1N44S	80%	85%	89%
492-1N45N	89%	94%	99%
492-1N46S	87%	93%	98%

**Loading on Scotia Street Network Feeders.**

#### 4 kV Substation

Scotia Street Station #492 supplies one 4 kV station, Beacon Street, Station #49 Kenmore Square.

<b>4 kV Station</b>	<b>2002 Peak (MVA)</b>	<b>LTE Capacity (MVA)</b>	<b>2004 Projection (MVA)</b>
Kenmore Sq Sta #49	20.25	16.3	17.0

### **Proposed Integrated Plan**

The development of the new Colburn Street 115/14kV substation will provide capacity to relieve five heavily loaded bulk supply stations: Andrew Square Station 106, Brighton Station 329, Dewar Street Station 483, Scotia Street Station 492 and Hyde Park Station 496. Prior to June 1, 2005 the Colburn Street Station project will install several new lines which will support the relief of Scotia Street Station by cutover Station 49 in Kenmore Square area and Northeastern University Station 573; provides up to 23 MVA of relief and alleviates the heavy loading condition at Scotia Street Sta #492 (88% of Firm Capacity – 2008 Summer).

The heavy loading conditions on the network feeders will be addressed by extending and reconductoring feeders within the network.

The heavy loading conditions on Kenmore Square Station #49 4 kV distribution circuits will be mitigated by conversion of the portions of the 4kV distribution circuits to 14 kV.

- 2004 Partial Conversion of 49-07 to 14 kV, 1500KVA. Also relieves the heavy loading condition at Station #49.
- 2006 Partial Conversion of 49-08 to 14 kV, 900KVA. Also relieves the heavy loading condition at Station #49.
- 2008 Partial Conversion of 49-01 to 14 kV, 1000KVA. Also relieves the heavy loading condition at Station #49.

### **After Colburn Street Station**

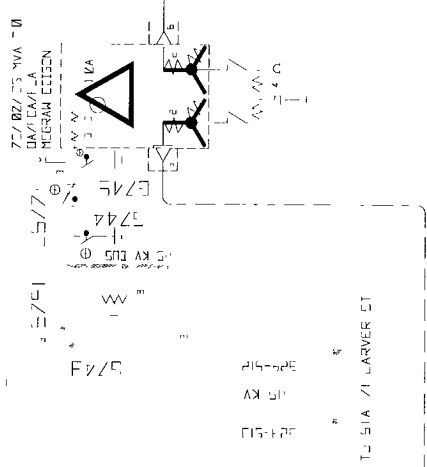
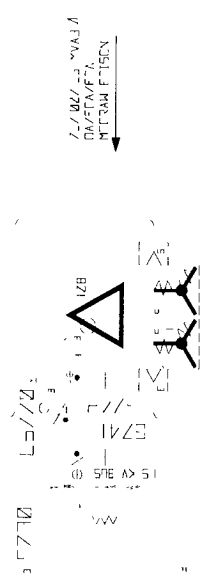
The spare feeder positions at Scotia Street Station #492 will be used to install new network feeders to relieve the loading on the distribution network.

- 2006 Use 49-210 feeder position @ Sta #492 to relieve 492-1N11N & 492-1N12N; install 3500 feet of cable.
- 2007 Use 573-212 feeder position @ Sta #492 to relieve 492-1N22N & 492-1N24N; install 2500 feet of cable.
- 2007 Use 49-209 feeder position @ Sta #492 to relieve 492-1N32N, 492-1N33S & 492-1N34S; install 3000 feet of cable.
- 2007 Use 49-211 feeder position @ Sta #492 to relieve 492-1N32N, 492-1N33S & 492-1N34S; install 2000 feet of cable.

<b>Action</b>	<b>Year needed</b>	<b>Cost</b>
⇒ Reconductor 492-1N11N	2004	\$100 K
⇒ Reconductor 492-1N45N	2004	\$100 K
⇒ Reconductor 492-1N46S	2004	\$100 K
⇒ Reconductor 492-1N25N	2004	\$100 K

- |  |           |     |
|--|-----------|-----|
| ⇒ Relieve Scotia Street Station #492 by cutover Station 49 in Kenmore Square and Northeastern University Station 573 to Colburn Street Station | 2005      | TBD |
| ⇒ Either install new feeders or reconductor existing feeders at Scotia Street Sta #492   | 2006-2008 | TBD |

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## ***2004 T&D OPERATING STUDY Boston District***

### **STATION #496 HYDE PARK**

Hyde Station 496 serves a power supply area consisting of the City of Boston neighborhoods of Hyde Park, Jamaica Plain, Mattapan, Roslindale, and West Roxbury and portions of the towns of Canton, Dedham, Milton and Westwood. During the summer of 2002, Hyde Park Station peak load was 155 MVA.

Hyde Park Station 496 consists of two 115/13.8 kV transformers:

Transformer #110A: General Electric 84 / 112 / 140 MVA 115 to 14.4/14.4 kV

Transformer #110B: General Electric 84 / 112 / 140 MVA 115 to 14.4/14.4 kV

Hyde Park Station 496 total capacity is 280 MVA. NSTAR employs summer emergency rating (cyclic capability) of 151 MVA for each of these two banks. Station 496's firm capacity is 151 MVA. Hyde Park Station 496 has approximately 13.5 MVA of manual and RADSEC transfer switching to adjacent stations Andrew Square Station 106, Brighton Station 329, Canton Station 470 and Dewar Street Station 483. Hyde Park's load carrying capability is 164.5 MVA.

### **Overload Ratings:**

Transformer	Nameplate	12 hour LTE, 90F Ambient	12 hour LTE, 110F Ambient
110A	84/112/140 MVA	182 MVA	170 MVA
110B	84/112/140 MVA	182 MVA	170 MVA

### **Station Capabilities:**

Total Station Capacity (N)	Station Firm Capacity (LTE)	RADSEC Transfer	Manual Transfer	Total LCC
280 MVA	151 MVA*	3.1 MVA	10.4 MVA	164.5 MVA

- Based upon loss of 110A/496-528 line or 110B/496-529 line.

### **Station Load Forecast:**

2004	2005	2006	2007	2008
167 MVA	172 MVA	176 MVA	179 MVA	181 MVA

### **Switching Actions:**

#### **Loss of Transformer #110A and 496-528 Line**

**Open:** OCB's 14 & 15 @ Baker St

***Circuit Switcher CS770***

Both Main 110A 13.8kV Circuit Breakers

**Close:** ABR scheme closes bus ties automatically

Manually close OCB's 14 & 15 @ Baker St

**Loss of Transformer #110B and 496-529 Line**

**Open:** OCB's 4 & 5 and CS770 @ Baker St  
Circuit Switcher CS771

Both Main 110B 13.8kV Circuit Breakers

**Close:** ABR scheme closes bus ties automatically  
Manually close OCB's 4 & 5 and CS770 @ Baker St

**Transfer Switching:**

For either transformer outage, remaining transformer carries full station load of 167.0 MVA. Station 496 Hyde Park has 13.5 MVA of manual and RADSEC transfer capability to adjacent stations.

While not required for loss of either transformer, transfer of the following circuits and DSS lines via RADSEC and manual switches may also be conducted for load relief:

Hyde Park 496-H2 to Canton 470-H7 via RADSEC MRU 841 and manual switch on P3/224 for a transfer of 4.4 MVA

Hyde Park 496-H4 to Andrew Square 106-H4 via RADSEC MRU switch P84/2 and RADSEC MRU P84/1 for a transfer of 3.1 MVA

Hyde Park 496-H1 to Dewar Street 43-1490H via manual switch "A" at PMH5731 and the Station breaker at Station 496 for a transfer of 3.5 MVA

Hyde Park 496-H5 to Brighton 506-140H1 via RADSEC MRU and manual switch on P113/40 for a transfer of 2.5 MVA

**Total Transfer:** 13.5 MVA

**Summary of Concerns: Hyde Park Region:**

Based on load projections, by in the summer of 2004 for a single-contingency outage of either transformer 110A or 110B, Hyde Park Street Station 496 will exceed the load carrying capability capacity. The new load will strain the capability of Hyde Park Station 496 substation and distribution infrastructure to support the customer load requirements.

By the summer of 2008 for a single-contingency outage of either transformer 110A or 110B, Hyde Park Station 496 could attain a loading of 112% of Load Carrying Capability and the load at risk would be 21 MVA.

**Transmission:**

1. Loss of double circuit tower line 110-522 & 240-510 overloads 110-510/511 (Baker-Washington Tap 115 kV lines). Due to this n-1 transmission constraint the load carrying capability of Station 496 is limited to 164.5 MVA. (2004)

**Distribution:**

1. Hyde Park Station 496 over load carrying capability for (n-1) conditions (2004)
2. Hyde Park Station 496 - short circuit current /overloaded transformer secondaries (2004)
3. Hyde Park line group overloaded under contingency conditions (2004)
4. Roslindale line group overloaded under contingency conditions (2004)
5. 4kV Stations 13, 60, 284 362, and 441 are overloaded under contingency conditions (2004)
6. 4kV line 60-03 overloaded under normal conditions (2004)
7. 14 kV Distribution circuits 496-H2 and 496-H3 (2005) and 496-H4 (2006) are overloaded

under normal conditions.

8. 4kV lines 13-10, 13-11, 362-02, 441-01, and 60-06 (2008)
9. 4kV Station 441 is overloaded under contingency conditions (2008)
10. Jamaica Plain line group overloaded under contingency conditions (2008)
11. Brook Road line group overloaded under contingency conditions (2008)

## Distribution Systems

### DSS Lines

Four line groups (Jamaica Plain, Roslindale, Brook Road, and Hyde Park) were evaluated for N-1 conditions for projected 2004 and 2008 loading.

- The Jamaica Plain line group, which supplies the Shattuck Hospital, the Faulkner Hospital and NSTAR 4kV Station 284, was found to have issues during the loss of line 536-76H in 2004 and beyond. During a line outage at least a 25% of the load is at risk because the load transfer puts the receiving line over its LTE rating. Line 313-80 becomes an issue in 2008.
- The Roslindale line group, which supplies the Roslindale Square Section of Boston via NSTAR 4kV Station 13, was found to have issues during the loss of any line in the line group in 2004 and beyond.
- The Brook Road line group, which supplies the Town of Milton via NSTAR 4kV Station 362 and direct 13.8kV distribution, was found to have N-1 issues beginning in 2008. Approximately 5% of the load is at risk during a line outage because the line receiving the load transfer exceeds its LTE rating.
- The Hyde Park line group, which supplies the Readville section of Hyde Park via NSTAR 4kV Station 344 and direct 13.8kV distribution, was found to have N-1 issues with two of three lines in 2004 and beyond.

DSS Line	% of Normal 2004	LTE - % Load at Risk 2004	MVA at Risk 2004	LTE - % Load at Risk 2008	MVA at Risk 2008
536-76H	48%	0%	0	1%	0
313-80	69%	0%	0	0%	0
284-79	71%	0%	0	7%	.5
284-75H	82%	0%	0	0%	0
143-81XYH	45%	0%	0	0%	0
13-1419	87%	22%	2.1	40%	4.1
13-1418	84%	20%	1.8	38%	3.8
13-1417	96%	2%	0.1	17%	1.3
13-1416XY	102%	12%	1.3	32%	3.8
362-1209	86%	0%	0	6%	0.5
362-1207H	108%	0%	0	5%	0.5
344-1413H	90%	17%	1.3	28%	2.3
344-1412H	109%	0%	0	0%	0
344-1411H	46%	14%	0.5	34%	1.5

*Loading on Hyde Park DSS lines.*

**14kV Distribution**

One of the six 14kV radial lines, 496-H5, is projected to exceed its normal rating in 2005. By 2008, 496-H2, 496-H3 and 496-H5 will exceed their normal rating. The new Colburn Street Substation will provide added distribution capacity to the Hyde Park.

<b>14 kV Radial Line</b>	<b>Summer Normal Rating in Amps</b>	<b>Projected % of Normal 2004</b>	<b>Projected % of Normal 2008</b>
496-H1	290	70%	74%
496-H2	360	99%	<b>107%</b>
496-H3	360	99%	<b>107%</b>
496-H4	360	91%	99%
496-H5	360	95%	<b>110%</b>
496-H6	360	80%	87%

*Loading on Hyde Park Station 14kV radial lines.*

**4kV Substation**

Hyde Park Station 496 feeds seven 4 kV stations: Roslindale Station 13, Jamaica Plain Station 284, Freemont Street Station 311, Readville Station 344, Brook Road Station 362, Cummings Highway Station 441 and Cleary Square Station 60. Six of the seven 4kV stations supplied by Hyde Park Station 496 are projected to exceed their long-term emergency ratings. The table below summarizes the capacity of these 4 kV stations.

<b>4 kV Station</b>	<b>2002 Peak (MVA)</b>	<b>LTE Capacity (MVA)</b>	<b>2004 Projection (MVA)</b>
Roslindale 13	12.0	<b>13.7</b>	<b>14.2</b>
Jamaica Plain 284	12.0	<b>13.8</b>	<b>14.4</b>
Freemont	18.6	18.2	<b>18.9</b>
Dorchester 311			
Neponset Valley 344	12.0	9.3	9.7
Brook Rd Milton 362	6.0	<b>6.0</b>	<b>6.3</b>
Cummings Highway 441	9.0	<b>12.0</b>	<b>12.5</b>
Hyde Park 60	6.3	<b>7.4</b>	<b>7.7</b>

*Loading on 4 kV stations fed from Hyde Park Station 496*

**Proposed Integrated Plan**

The suggested actions table listed below will address all of the capacity concerns in the region.

The proposed Colburn Street Substation will have a significant impact on the substation and distribution capacity in the Hyde Park Station area. The substation and associated distribution infrastructure will provide the foundation for all of the Hyde Park area capacity needs for the next 5 years. The development of the new Colburn Street 115/14kV substation will provide capacity to relieve Hyde Park Station # 496. Prior to June 1, 2005 the Colburn Street Station project will establish several new lines which will support the relief of Hyde Park Station 496 by 20.5 MVA of load. The new Colburn Street lines will allow for the release of Hyde Park feeders for use in the Hyde Park supply area. The new Colburn Street station will supply Brookline Village and Jamaica Plain area loads currently served by Hyde Park. The station relief provided by the Colburn Street substation will provide the Hyde Park Station with adequate substation capacity to meet the capacity

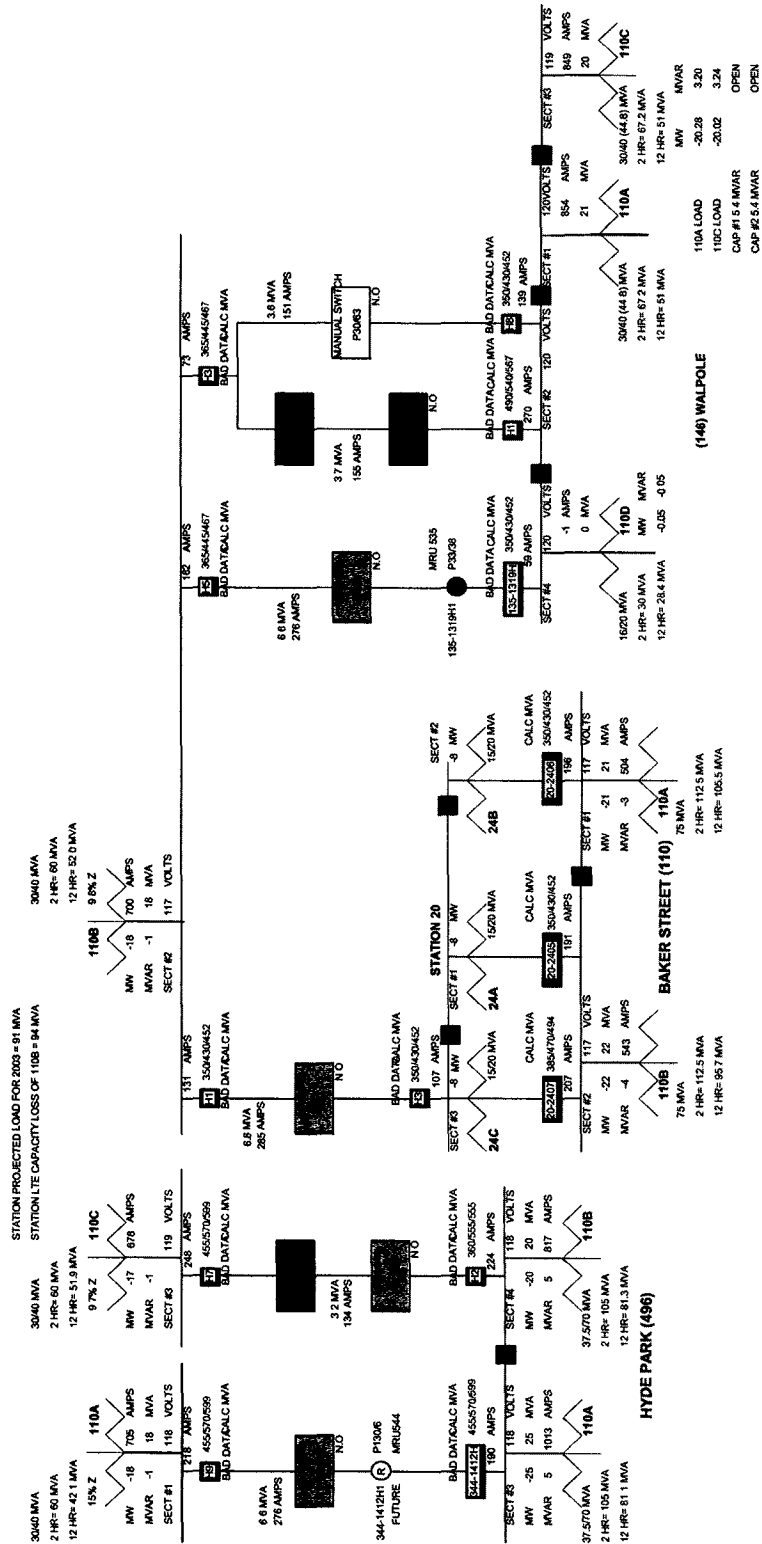


requirements of the Hyde Park supply area through 2008. The Hyde Park station relief will also alleviate the n-1 transmission over load condition on the 110-510/511 (Baker-Washington Tap 115 kV lines during the loss of the double circuit tower line 110-522 & 240-510. The Colburn Street project will address capacity issues on the Roslindale and Jamaica Plain line groups, and circuit 496-H3. The new distribution circuits will also create transfer capabilities between Hyde Park Station 496 and the new Colburn Street Station # 350, allowing for increased substation transformer utilization.

Action	Year needed	Estimated Cost
⇒ New Colburn Street Substation <b>see Brighton Area</b>	2004 - 05	
⇒ Installation of line reactors on 2 distribution circuits off of busses 1 & 2 at Station 496 reconfiguration of distribution circuits 496-H1 & H3 and installation of ABR schemes at 4kV Stations 311, 362 and 441	2004	\$400K
⇒ Partial conversion of 4kV circuit 60-03 to relieve circuit and station 60	2004-05	\$500K
⇒ Replace two 5 MVA 14kV/4kV transformers at Station 13	2004	\$200K
⇒ Install fans on three 5 MVA 14/4kV transformers at Station 284	2004	\$50K
⇒ Install fans on transformer 14A at Station 441	2004	\$15K
⇒ Relief of circuit 496-H5 to 496-H4	2005	TBD
⇒ Install fans on transformers at Station 311 or Relieve Station 311 – Convert portions of circuits 311-08	2005-06	TBD
⇒ Install fans on transformers at Station 362 or Relieve Station 362 – Partial conversions of circuits 362-02 & 05	2005 -06	TBD
⇒ Install new circuit from Station 483 to relieve the Brook Road line group or transfer load to adjacent line	2006	TBD
⇒ Establish new distribution circuit at Station 496 to relieve H-P line group or transfer load to adjacent line	2006	TBD
⇒ Install fans on transformers at Station 60 or Convert portion of 60-03 to relieve circuit and station 60	2008	TBD

*Recommended course of action for the Hyde Park Region*





## ***2004 T&D OPERATING STUDY MASS. AVENUE DISTRICT***

### **STATION #514 KINGSTON STREET**

Kingston Street Station #514N supplies the Downtown Crossing/Theater/Chinatown/Leather districts of the City of Boston. In the summer of 2002, the Kingston Street Station #514N load was 124 MVA.

Prior to the 2003 summer cut-over (i.e. transfer) the Secondary Network Vaults and Tertiary Network Vaults within the Leather District presently supplied from Kingston Street Station #514N to High Street Station #53. This project transferred 18 MVA of load from Kingston Street Station #514N to High Street Station #53 and restores the Leather district to its original (i.e. pre-Central Artery) distribution network configuration and station supply. The cost of this work was reimbursed by the Central Artery project. The load transfer from Kingston Street Station #514N to High Street Station #53 will reduce the Downtown Crossing/Theater/Chinatown/Leather region's load by 18 MVA.

Kingston Street Station #514N consists of the following transformers:

Transformer #110A: McGraw-Edison 84 / 112 / 140 MVA 115 to 14.4/14.4 kV

Transformer #110B: McGraw-Edison 84 / 112 / 140 MVA 115 to 14.4/14.4 kV

Kingston Street Station #514N total capacity is 280 MVA. NSTAR employs summer emergency rating (cyclic capability) of 151 MVA for each of these transformer banks. The station has a firm capacity of 151 MVA. As a secondary network station there is no transfer switching capability to adjacent network stations. Kingston Street's load carrying capability (i.e. firm capacity + transfer switching) is 151 MVA.

### **Overload Ratings:**

Transformer	Nameplate	12 hour LTE, 90F Ambient	12 hour LTE, 110F Ambient
110A	84/112/140 MVA	180 MVA	168 MVA
110B	84/112/140 MVA	180 MVA	168 MVA

### **Station Capabilities:**

Total Station Capacity (N)	Station Firm Capacity (LTE)	RADSEC Transfer	Manual Transfer	Total LCC
280 MVA	151 MVA*	0 MVA	0 MVA	151 MVA

\* Based upon loss of 110A/385-510 or 110B/385-511.

### **2004-2008 Projected load:**

2004	2005	2006	2007	2008
139 MVA	140 MVA	142 MVA	145 MVA	147 MVA

**Switching Actions:**

Loss of Transformer #110A also isolates the 385-510 Line and Transformers 110A&110B @ High St

- Open:** OCB's 8 & 9 @ Kingston St  
OCB's 10 & 11 @ K Street  
Circuit Switchers CS770 (110A Tranf) and CS773 (110B Tranf) @ High St  
Circuit Switcher CS771  
Both Main 110A 13.8kV Circuit Breakers
- Close:** Nothing, bus tie operated normally closed  
Manually close OCB's 8 & 9 @ Kingston St  
Manually close OCB's 10 & 11 @ K Street  
Manually close Circuit Switchers CS770 and CS773 and restore 110A & 110B @ High St

Loss of Transformer #110B also isolates the 385-511 Line and Transformers 110C&110D @ High St

- Open:** OCB's 6, 10 & 11 @ Kingston St  
OCB's 17 & 18 @ K Street  
Circuit Switchers CS776 (110C Tranf) and CS775 (110D Tranf) @ High St  
Circuit Switcher CS770  
Both Main 110B 13.8kV Circuit Breakers
- Close:** Nothing, bus tie operated normally closed  
Manually close OCB's 6, 10 & 11 @ Kingston St  
Manually close OCB's 17 & 18 @ K Street  
Manually close Circuit Switchers CS776 and CS775 and restore 110C & 110D @ High St

**Summary of Concerns:**

1. Network feeders overloaded under contingency conditions (2004-2008)

The Downtown Crossing/Theater/Chinatown/Leather districts continue to evolve through various development stages. The region is a highly mixed area including office buildings, hotels, residential apartments and condominiums, retail shops, restaurants and entertainment that maintain a lively set of activities both day and evening. Much of the impetus for the continued development comes from the region's being a vibrant and economically active portion of the city of Boston. The anticipated development will significantly increase the load within this region.

Based on load projections, by in the summer of 2008 for a single-contingency outage of either transformer 110A or 110B, Kingston Street Station #514N will be loaded at 97% of the firm capacity.

## Distribution Systems

### 14 kV Network Feeders

There are twenty-four network feeders supplied from Kingston Street Station #514N. By the summer 2004 six network feeders will exceed 100% of normal rating and another five will be heavily loaded exceeding 90% of normal rating. The following table summarized the performance of the network feeders.

<b>14kV Network Lines</b>	<b>% of Normal 2002</b>	<b>Projected % of Normal 2004</b>	<b>Projected% of Normal 2008</b>
514-1N11S	89%	90%	95%
514-1N12N	51%	67%	71%
514-1N13N	48%	63%	6%
514-1N14N	29%	39%	41%
514-1N15N	64%	85%	89%
514-1N16N	115%	105%	111%
514-1N21N	68%	89%	94%
514-1N22N	83%	109%	115%
514-1N23N	41%	54%	57%
514-1N24N	54%	71%	76%
514-1N25S	98%	95%	100%
514-1N26S	79%	101%	107%
514-1N31N	80%	105%	111%
514-1N32N	41%	54%	57%
514-1N33N	37%	49%	52%
514-1N34N	68%	89%	94%
514-1N35S	74 1/2%	90%	95%
514-1N36S	82%	107%	113%
514-1N41N	62%	82%	95%
514-1N42N	52%	68%	78%
514-1N43N	76%	100%	116%
514-1N44N	69%	90%	104%
514-1N45S	65 1/2%	95%	110%
514-1N46S	78%	77%	90%

### ***Loading on Kingston Street Network Feeders.***

### Proposed Integrated Plan

The heavy loading conditions on the network feeders especially supplying the east grid within the Kingston Street Station #514 network will be addressed by extending and reconductoring feeders within the network.

<b>Action</b>	<b>Year needed</b>	<b>Cost</b>
⇒ Reconfigure 514-1N25S	2004	\$100 K
⇒ Reconductor and reconfigure 514-1N36S	2004	\$100 K

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⇒ Reconductor and reconfigure 514-1N45S	2004	\$100 K
⇒ Reconductor 514-1N35S	2004	\$100 K
⇒ Either reconductor 514-1N26S or transfer load to adjacent network feeders	2008	TBD
⇒ Reconductor 514-1N44N or transfer load to adjacent network feeders	2008	TBD

# NOTES

ALL 480 VOLT - 752 1200A & 1000A VACUUM BREAKERS  
KEY INTERLOCKED - SERVICE SET BREAKER MUST BE  
DOWN TO PERMIT WITHDRAWAL OF PRIMARY FUELS ROD  
OPERATING POSITION  
TRIP IT SWITCHES EQUIPPED WITH SHUNT TRIP DEVICE  
KEY INTERLOCKED TO PREVENT GROUND BLADES FROM  
BEING CLOSED WHILE CIRCUIT SWITCHER IS CLOSED

SUPERVISORY CONTROL AND INSTRUMENTING SYSTEM TO STATION  
1125 VOLT CONTROL BATTERY WITH CHARGER  
RADIO CONTROLLED (RAD RELIEF) AVAILABLE AT THIS STATION  
1140 VOLT SUPERVISORY CONTROL EQUIPMENT AVAILABLE WITH  
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